

Editorial



FROM this month's issue, the name of our magazine has been changed to RADIO, TELEVISION AND HOBBIES. It is the first we have made in our sixteen years of existence.

One does not change a well-established name without good reason. The abbreviation of R & H is now known throughout the length and breadth of the land. Many of our readers have literally grown up with it. Editorially, it has become synonymous with our past activities and ideals.

But when we published the first issue, TV was a long way off. It had barely made a start as a regular service in England, and was still regarded as a nine-day wonder.

But things have altered. Today we look forward to having a TV service in Australia within a measurable time.

It is inevitable, therefore, that, as time goes on, our magazine will begin to devote more of its space to matters concerning TV. There is so much to be done. There is an educational program designed to teach our readers more about the complexities of the art, and of these there are many.

We have already made a start with a series of articles on TV which have appeared over the last few years, and it was felt that the time had come to add the word TELEVISION to our name in order that it should more adequately describe the field we intend to cover.

The change does not mean that our magazine will embark on a drastically new form, or that any of the features you look forward to each month will be abandoned.

It simply means that we recognise officially the necessity of including this new field in our work, and that we pledge ourselves to do all we can to encourage its correct use in the best way for our country and for ourselves.

The omission of the words IN AUSTRALIA have no particular significance. When our first issue was published, it was our intention to build up the magazine into a national journal, and it was felt that these words were appropriate to that aim. But today our national position is so clearly established that they are not necessary.

We still retain the word HOBBIES because, although radio through its popularity has dominated the magazine, we still wish to include other matter not directly concerned with radio as the opportunity allows.

We know you will wish us well under our new name. It is our earnest hope that we will be able to live up to it.

John Boyle

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RADIO

TELEVISION & HOBBIES

A NATIONAL MAGAZINE OF RADIO, TELEVISION, HOBBIES AND POPULAR SCIENCE

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OUR COVER PICTURE

The abacus, still used in China for counting purposes, is here compared with a magnetic memory matrix from an electronic computer. It is capable of storing 1000 "bits of information.



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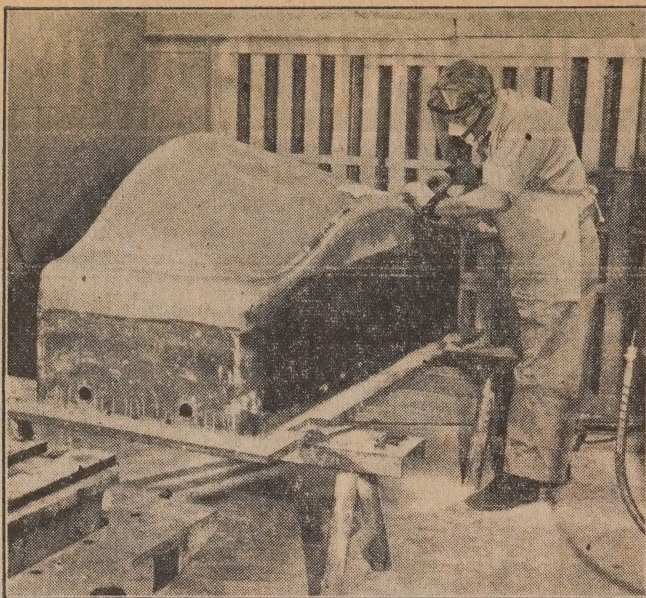
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AIRCRAFT TOOLS FROM PLASTIC



This plastic overpress template is used as a drill guide in fabricating the tail fairing for the Lockheed Super Constellation. Use of plastic tools cuts over-all manufacturing costs 25 pc and saves 50 pc of the time required to produce an indential template out of metal. [See story next page.]



A plastic shop technician installs steel gripper beads in the grooves of a plastic double-action die. Records show that a typical plastic die can be made in 770 hours of labor compared to a minimum of 2000 hours required to make a similar piece out of metal.

this material in 60 pc of the time formerly required, and they are produced to closer tolerances—at only half the cost of old-style metallic dies.

Plastic materials permit production men to cast a precision die surface from a model without machining or hand finishing, both highly expensive and time-consuming procedures required for metallic dies.

ADVANTAGES

Here are some additional advantages Walkey reported from the use of plastic dies:

- 1.—Tool costs reduced to 50 pc of previous costs.
- 2.—Production time lost in maintenance and replacement of dies reduced 65 pc.
- 3.—Simplified use of production presses, with parts now turned out of inexpensive drop hammers (like huge blacksmiths' hammers) instead of high-cost double-action presses.
- 4.—About 5000 man-hours a month saved in construction and maintenance of lead punches (the metal die part which fits into a master form). Formerly replacement of a lead punch required four hours of work and the new part was capable of 100 hours of production. Lead punches now in use are being resurfaced with tougher, longer-lasting plastic.
- 5.—Wrinkles in airframe parts reduced; costly "speed-hammering" formerly necessary to take out wrinkles and surface imperfections reduced or eliminated.
- 6.—Increased accuracy of production with durable plastic dies.
- 7.—Economies further increased by

PLASTIC DIES—CHEAPER PLANES

Reversing the usual order, plastics are now being used to form, trim and drill metal parts needed for commercial and military aircraft. What is more they are doing it cheaper and faster than the traditional dies and guides they replace

THE new plastics family includes some fantastic names—phenolics, polyesters and epoxies—but all of them produce revolutionary savings in time, work and money. And they produce better aeroplanes faster, according to Lockheed engineering and manufacturing specialist G. J. Walkey.

These plastics are tough enough to be used for forcing rugged stainless steel and aluminium alloys into the complex high-strength shapes necessary for reliable fighters and transports. Automobile makers also are using the material for production tools.

BETTER DIES

People usually think of plastics in connection with products ranging from flexible raincoats to rigid resins for table tops. But plastics also are more efficient as well as more economical than unwieldy metal dies for producing scores of aircraft parts.

The men using such plastic dies accept them and use them as if they were made of the heaviest die metal in existence.

Booming now, plastics will be-

come even more important as Lockheed moves into full swing production with advanced C-130 turbo-prop cargo planes, fast new F-104 jet fighter planes and latest advances in the Neptune anti-submarine patrol series.

Walkey, who engaged in many of Lockheed's manufacturing research programs during the past 10 years, described the future of plastics for manufacturing tools as "limited only by engineers' imaginations".

Latest addition to the plastics die-making family is the epoxy-type resin, a highly stable by-product of petroleum that solidifies at room temperature. It's tough, but easily worked.

Some of the epoxy plastic dies, with aluminium powder content, even look like metals.

Epoxies usually are used only in die-faces, the master part which fits into mammoth presses and actually comes into contact with the metals to be pressed into shape. Lockheed produces many of its most complex airframe parts with approximately 100 epoxy plastic dies.

Tools and dies can be made from

permitting reclamation of zinc alloy die backings.

Biggest of the epoxy plastic-faced dies produced so far by the manufacturer are multiple dies used to form landing gear door inner skins. These are used with the Hall of Giants' huge 8000-ton hydraulic press.

But the company has made even larger dies of other plastic materials. Stretch press dies as large as 15 ft by 4 ft have been produced of phenolic plastic with a total weight of 3500 lb compared to similar metallic dies which would have weighed ten times as much.

EVERYDAY USE

Plastic tooling ceased to be an experiment at Lockheed five years ago. Now the making of plastic dies and tools is a well-established and ever-expanding operation, keeping 80 to 100 men busy in a 175,000-dollar plastic tool shop.

In two years Lockheed used 197,000 pounds of phenolic plastic replacing more than 1,800,000 pounds of Kirksite, a metal alloy which

formerly was the leading die material.

Especially significant is the ability to fabricate extra-large parts, previously out of the question because metal dies would have been too heavy to handle. There would have been other disadvantages as well.

Plastics took on added significance when Lockheed was committed to a philosophy of building airplanes of larger, stronger, one-piece structures—and at the same time—through fullest exploitation of the company's Hall of Giants which is filled with some of the aircraft industry's largest presses and machines.

Plastics fit right into that new philosophy of aircraft production, Walkey said. They make possible large dies for producing large one-piece parts for aeroplanes.

VARIETY OF TYPES

Like other aircraft manufacturers, Lockheed produces its own tooling—and lots of tooling is needed because of the variety of parts required by the industry and because of the company's diversification of models.

Quantity requirements are usually low for any individual part, because of frequent advances in design. For example, the Super Constellation progressed from the 1049C through the 1049E and G models in approximately two years.

And today the transport is marking further advances as the R7V-2 turbo-prop for the US Navy. It is now under flight tests as the world's fastest propeller-driven transport.

The famed P2V Neptune, since 1946 the holder of the world's non-stop distance record of 11,236 miles without refuelling, has undergone similar advances, with most of the later design features adaptable to earlier models.

Tools quickly become outmoded because of aircraft advances, but plastic dies for earlier models often can be modified to meet the new requirements. Old style metallic dies also can be modified with new plastic faces, Walkey explained.

"Die modifications might be compared to 'patching' the earlier tool," he pointed out.

The cost is "negligible" compared to that of metallic die replacement.

Besides dies, Lockheed production specialists produce plastic templates, patterns and other tools, Walkey said. Drill patterns, for example, may be produced by casting the plastic directly against the aircraft part, thus reducing production costs. The finished tool is lighter than comparable steel tools.

Table type drill jigs are light enough to be lifted by women workers.

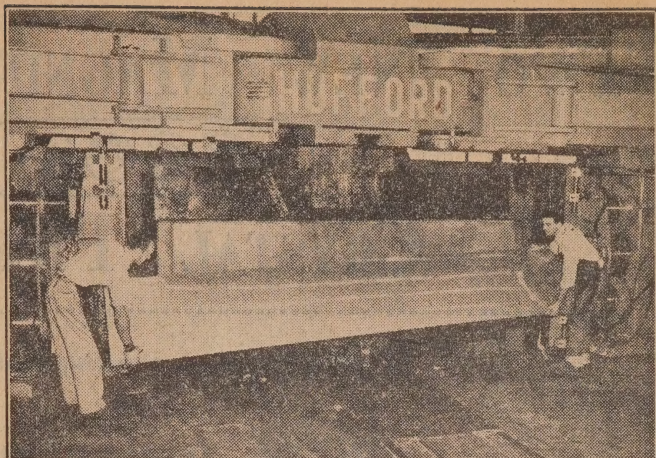
SAVING IN TIME

In addition to saving materials, tool production time is reduced about 50 pc by the use of plastics, permitting fast production schedules to be met. These time savings have meant "on schedule" deliveries in notable instances, the Lockheed specialist said.

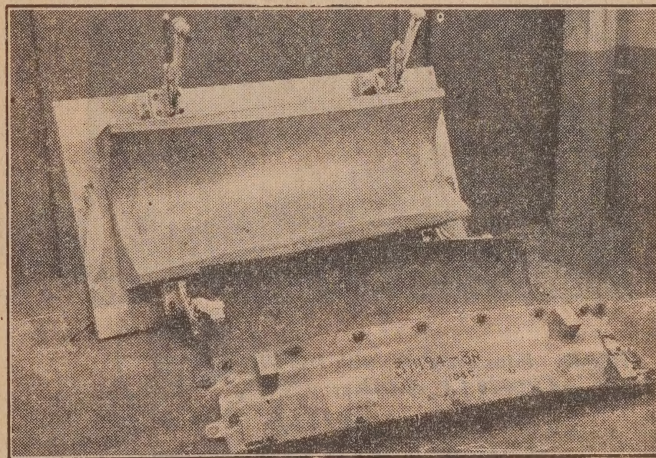
Router fixtures—devices which serve as patterns for trimming high strength metal aeroplane parts after shaping—also may be made of the new materials.

A plastic core, with Kirksite cut-

(Continued on Page 9)



Operators remove a 15 foot skin section for a Constellation transport formed on a plastic die in a 200-ton stretch press. The die weighs 3500 pounds. Weight of a similar die constructed of metal would have made handling prohibitive, since it would gross 17½ tons.



Typical drill jigs of Rezolin Tool Plastic. Bottom jig is made of Fiberglass.



A plastic contour drilling jig in use.

TWO NEW MAGNIFICENT Hi-g



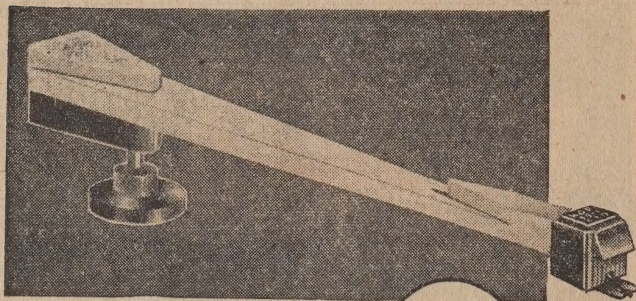
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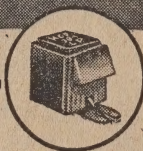
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USAF GETS FIRST "SPACE SHIP"

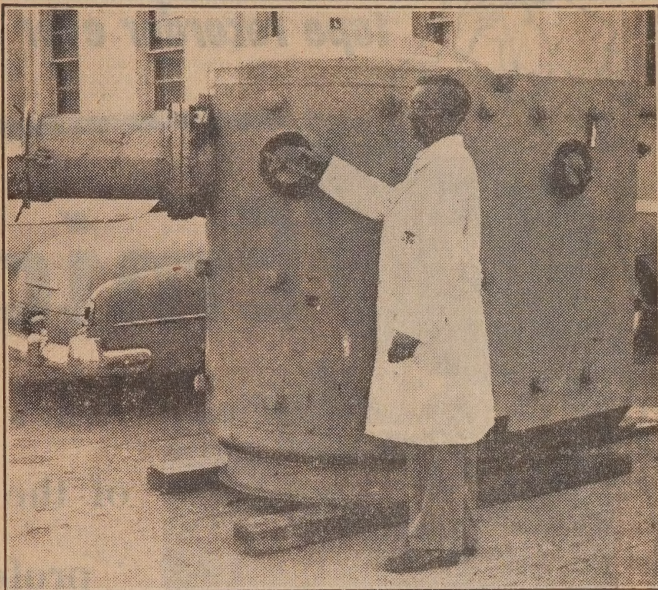
The first piece of experimental equipment ever built specifically for the study of living conditions in space has just been delivered to the US Air Force School of Aviation Medicine.

KNOWN as a "sealed cabin", it was designed to investigate human factors inside the cramped quarters of a space ship, flying far outside the useful limits of the earth's atmosphere.

Except that it doesn't fly, the cabin will give aeromedical researchers at the Randolph Field institution most of the sensations they would experience on a flight of several hours or days in space.

The sealed cabin is a joint project of the school's departments of Physiology and Space Medicine. It is under the immediate supervision of Dr. Hans-Georg Clamman, an authority on the body's functions at very high altitudes.

It looks more like an ordinary house furnace than like artists' conceptions of a sleek space craft. Actually it is a first cousin of the low-pressure chambers in which aeromedical specialists for some years have studied human reactions



Externally, the sealed cabin is a far cry from a sleek space ship but Dr. Clamman is hopeful that the conditions which can be simulated inside it will yield valuable research data. The interior isn't exactly spacious as Dr. Clamman demonstrates (left)



to the thin air in the stratosphere and beyond it.

But low-pressure chambers—or altitude chambers, as they are sometimes called—reproduce conditions in the air outside the craft. They tell the physiologist what happens when things go wrong and a pressurized plane loses its pressure.

The sealed cabin, on the other hand, tells him what goes on inside the craft, where a careful balance of atmospheric conditions must be artificially maintained. As its name implies, the sealed cabin is hermetically closed off from the sky outside.

The reason it is needed is that pressurized cabins of the conventional type cannot be used above 80,000 feet. There is so little air at that height that present-day compressors cannot pump in enough of it to keep the flier safe from various kinds of altitude sickness.

Besides, the outside air above 80,000 feet contains ozone. Contrary to the popular impression of ozone as a healthful and invigorating element, it is a harmful gas in high concentrations. In medicine it is sometimes used as an antiseptic and a disinfectant. Drawn into the cabin, it would do the flier no good.

But in a cabin sealed off from the outside air, as in a tightly shut closet, several uncomfortable things happen. For one, the occupant uses up oxygen at a rate of about 26

(Continued on next page)



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TR. 7. PP

SPACE SHIP

(continued from previous page)

quarts an hour. At the same time he exhales carbon dioxide, another unpleasant gas, along with water vapor that raises the humidity. He also produces body heat, which elevates the temperature.

The sealed cabin has to carry enough oxygen to replace what the flier consumes, and chemicals to remove the excess carbon dioxide and water vapor. It must have refrigerating equipment to control the heat. Since all these protective measures add weight to the craft, Dr. Clamann's object is to find out how little climatization the flier can afford to stand.

Another drawback in a sealed cabin is that the total air pressure cannot be too great, or the stress in the walls will become a structural hazard in the near-vacuum around the craft. So the physiologist and his associates must determine how little pressure the body can take without fear of the bends.

At the moment, Dr. Clamann is tinkering about a pressure equivalent to an altitude of 18,000 feet, where descendants of the Incas of Peru lived without difficulty in the mines of the Andes. His experiments will tell him whether this is a safe limit.

It will be some time before the sealed cabin can give him any definite results. Meanwhile, several test pilots in experimental rocket aircraft (among them William B. Bridgeman, Marine Lt.-Col. Marion E. Carl, and Air Force Maj. Charles E. Yeager) have already flown for brief intervals in the neighborhood of 80,000 feet.

Tomorrow's rocket ships are edging into the region where the men who fly them will have to sit inside a sealed cabin. So Dr. Clamann is working against time with his odd-looking tank at the school of Aviation Medicine, hoping he will have the answers when they are needed.

Plastic Dies—Cheaper Planes

(Continued from page 5)

edge for trimming, was developed to replace a wood form pattern block. With it, Lockheed workers processed 150 parts in 1½ hours. The old method took 40 hours, with 20 percent of the completed parts imperfect and therefore rejected. Negligible losses result from plastic tooling.

A wide variety of other important tools for building aeroplanes are made of plastics, including fixtures that hold individual parts in place for assembly into larger units; patterns for drilling precision holes for assembly purposes; guides for aircraft welders; tracing patterns for trimming parts; inspection devices; and spinning chucks for shaping metal on a lathe.

Additionally, many experimental tools of plastic materials are under study in Lockheed's continuing research program.

Yet another advantage of plastic tools and dies is the saving in critical materials. Plastics are available in quantity. No shortage would be anticipated if world emergency conditions should create a shortage of rare die metals.

HOW ATOMIC JETS COULD WORK

Man's dream of high-speed flight, free from worries about range and fuel, are moving rapidly to fruition, according to a recent article in the Wall Street Journal.

WITHIN the past year, scientists and engineers have tackled with some success the greatest single barrier to atom-powered flight—the massive shielding necessary to protect a plane's crew and passengers from radiation from the nuclear power plant.

Well to the fore in this research have been experts from the U.S. Atomic Energy Commission.

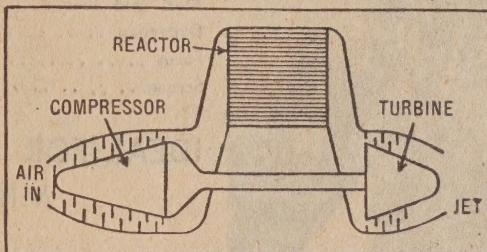
While tackling the radiation problem, they have also been able to sort out some of the difficulties of translating atomic energy into jet propulsion.

If the rate of progress is main-

shield down to the equivalent of a normal fuel load. The weight of fuel which an atom plane must carry can be neglected, since even one pound of uranium 235 can generate as much heat as 2-million pounds of gasoline.

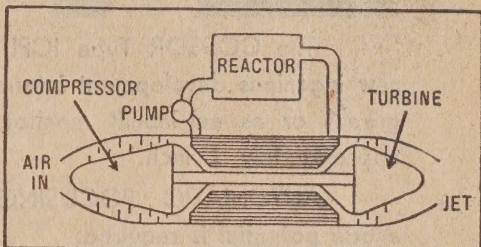
Although a strict security blanket surrounds most of the work, it seems that the shielding problem is yielding to the idea of using multiple partitions rather than a single massive shield, as was first envisaged.

An inner shield around the reactor is designed to minimize general radiation and at least to be sufficiently effective to prevent the



In a simple, direct-action jet, the air from the compressor or would simply be routed past the reactor, becoming heated in the process. Operation would be the same as if burning gasoline were used.

A "tidier" design might use liquid metal to transmit heat from the reactor to the air-stream in the jet motor. Ordinary fuel might even be used for takeoff, thus avoiding problems of radiation at airports.



tained, a complete new era in aircraft performance is not far off. Military planes will be able to mount guard over continents and oceans for days on end. They will be able to outstay even the latest submarines.

Attack aircraft will be able to fly any distance and return. Cargo and passenger aircraft will be able to travel non-stop between any terminals in the world, thus speeding up the service and cutting costs.

Initial estimates, soon after the war, set the minimum feasible weight of an atom power aircraft at about 500,000lb, with double this figure as a possibility. More recent work has pared the figure down to about 200,000lb, and possibly even less.

This is still a big plane, of course, but it is below the weight of some of the largest bombers at present in service.

When taking off, fully laden, a very large proportion of the gross weight of present aircraft is represented by fuel load—ranging from about one-third for a piston-engine plane to nearly 50 percent for a jet.

Aim of the atom scientist is to get the weight of reactor and

structure of the plane being affected. A further shield (or shields) would be concentrated around the area occupied by passengers and crew.

Motors could be more or less conventional jets but grouped close to the body and the reactor, to avoid waste of heat.

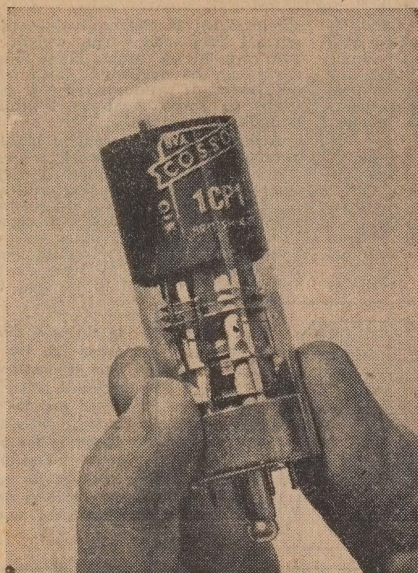
The structure of the plane would have to be modified to handle the changed weight distribution. Landing, also, would have to be modified, because the plane would not lose weight in flight.

Rather surprisingly, it is expected that tanks for conventional fuel won't entirely disappear from the first nuclear planes, though they'll be small. It is probable that early models will use their atomic energy for cruising at altitude, and rely on conventional liquid fuel for take-off and landing.

Some engineers remain sceptical and say it will be 15 years before a practical solution comes along. But the atomic enthusiasts cite the wide divergence in estimates of practicability and timing which have accompanied every atomic advance including the hydrogen bomb. The optimists have usually been right!

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BIGGER AND BETTER COLOR TV

Doubts and aspersions notwithstanding, the US radio trade is putting a tremendous effort into the field of color television. Bigger and better color tubes are the order of the day, with simpler circuits and lower prices as the next objective.

WHEN RCA more or less showed the way with their 15-inch tube, spectators watched the colored pictures with great interest. But they also registered the fact that the pictures weren't nearly so big—as bright either—as those from a good monochrome receiver. It was plain to see that color could be handicapped if it had to duck these objections, as well as the higher price. In fact, the whole success of color TV, from the buyer's angle, depended on getting bigger and cheaper tubes in ample quantities.

A TOUGH PROBLEM

It was one thing, of course, to state a problem, but quite another to solve it. RCA had had troubles enough getting out moderate quantities of their 15-inch tubes and the outlook wasn't too encouraging for other manufacturers who had ideas of mass-producing still larger ones. However, into it they went, with 9-inch tubes as the immediate target.

CBS-Hytron was first off the mark, in July last year, with the announcement of a tube which they hoped would sweep the market. It was a 19-inch tube, in which the image appeared directly on the inner face of the glass.

This, combined with a curved surface, gave them a vastly increased picture area, cleaned up the reproduction around the corners and simplified tube construction.

Of the fifty or sixty thousand



RCA's new 21-inch color TV tube is shown on the left, compared in size with the former 15-inch tube, as used in the original color receivers.

larger-screen tubes, which they estimated would be supplied to set manufacturers in 1954, Hytron hopes to make 80 pc. They were aiming at a production rate of 10,000 tubes per month, at a price to manufacturers of 175 dollars—and falling.

RCA, who looked like being left behind by their ambitious competitor, have since gone one further. Coming up behind their own 19-inch tube was a 21-inch developmental model which looked very promising. So promising, indeed, that RCA is talking down the 19-inch to concentrate on its big brother. Now it is being offered to the set manufacturers, along with other new developments.

Doing things in typical RCA style, they recently presented to manufacturers, at their Princeton laboratories, what they claimed to be "three milestones" in the progress of color TV.

1. "A new 21-inch RCA picture tube with 250 square inches of viewing area—22 pc more than any other color tube yet produced.

2. "A magnetic field equaliser called the 'color equaliser'. This is a significant new RCA invention, not previously announced, which guarantees improved color set performance and makes possible a reduction in manufacturing costs."

3. "A new, simplified color television receiver, which reduces circuitry by one-third and permits a substantial reduction in production costs."

QUANTITY PRODUCTION

RCA forecast that it would have sufficient tubes available to allow manufacturers to begin production in early 1955 with 21-inch picture tubes—the favored size for black and white receivers.

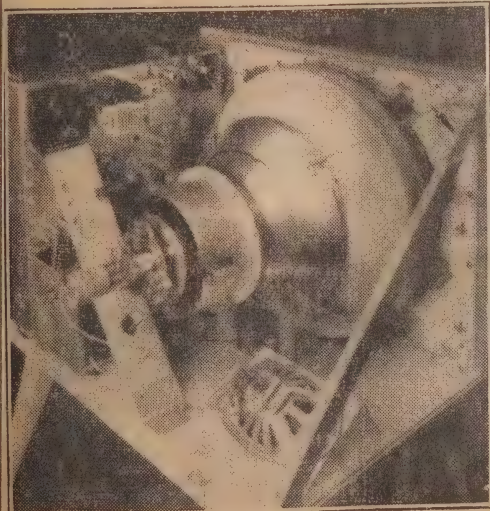
Their own set, using the tube, would sell for between 800 and 900 dollars.

The picture would compare favorably, in contrast and brightness, with present popular monochrome tubes. Reproduction would be sharp right out to the edges.

Regarding new "Color Equaliser", Dr. Engstrom, of RCA, has explained that, previously, the performance of color tubes was affected by magnetic fields such as the earth's field or local sources.

"To minimise such disturbances, tubes have been protected up to now with a conical magnetic shield which was effective in shielding the small end of the tube cone, but relatively less effective near the tube

(Continued on Page 83)



A rear view of the new simplified RCA color receiver, just announced. Using 28 tubes in all, including the picture tube, it has 11 fewer than its predecessor and 2 less than the first monochrome receiver. It covers all channels, VHF and UHF and draws 300 watts from the power mains. Note the position for the speaker on the floor of the cabinet.

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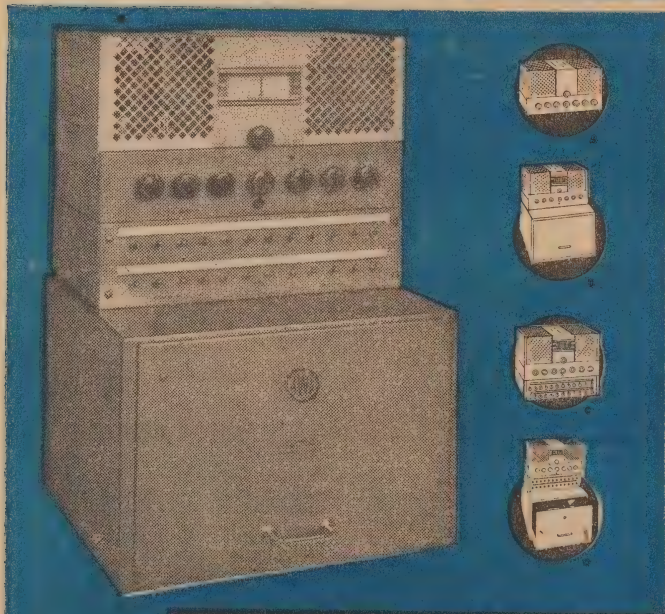


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PUTTING SUN'S ENERGY TO WORK

Three important inventions in the use of solar energy during the past few months and three international conferences indicate that the harnessing of the sun's energy is now approaching reality. There has long been talk of it—but that talk is now being focused into active projects.

By **DR. GERALD WENDT**

THE first meeting concerned engineers and industrial managers; when the South American section of the World Power Conference met in Rio de Janeiro, Brazil, in July, to discuss the practical realities of generating power from the sun and the wind.

The second was in October at New Delhi, India, where Unesco's Advisory Committee on Arid Zone research discussed the sources of energy available in desert areas. The third meeting was scheduled for January at Prescott, Arizona, in the United States, when the Stanford Research Institute planned to gather experts for a more theoretical discussion on the exact means by which sunshine is converted into other forms of energy, as in the growth of plants.

CONCENTRATED EFFORT

Thus, within six months, the world's knowledge of the scientific, engineering and useful aspects of the sun's energy will have been summarized.

Recent research has given very impressive results. In France large mirrors have gathered and concentrated enough of the sun's rays to produce temperatures as high as those in any electric furnace. In India smaller mirror systems have been used to cook meals and operate small steam engines. And in the United States a new generator has been devised to convert sunshine directly into electric current.

The most spectacular research is that of Professor Felix Trombe at the village of Mont Louis in the French Pyrenees, where one flat mirror, about 40 feet across, is mounted on a pivot so that it follows the sun's passage across the sky and reflects its rays to another mirror, which is so curved that it reflects all the rays on one point.

The concentration of so much energy into one very small spot raises the temperature of any object placed there to some 4500 deg. F., sufficient to melt all ordinary materials. It gives a unique means of research on the behavior of oxides and other ceramic materials at such high temperatures.

INDUSTRIAL USES

New heat-resistant materials must be developed for such uses as the jet engine, rockets and the atomic furnace, and the clean, smokeless but intense heat of the big French solar furnace can provide important information.

The use of the sun's energy at a lower temperature, just hot enough to boil water for cooking or for a steam engine, would be much more widely useful. The problem is essentially the same, namely to con-

centrate the rays from a broad area on a small one. This also means that the light must be gathered by means of mirrors and reflected on a receiver where it is put to work, but the mirrors and other equipment must be simple and inexpensive.

The simplest device is one developed for home use by the National Physical Laboratory at New Delhi in India. It consists of a metallic plate curved into a concave shape and supported on a stand so that the sun's rays are reflected upward from the polished metallic surface and are thus concentrated on an iron ring at the focus, or centre of curvature.

When a pot of water or of rice is set on the ring it absorbs the sun's heat from about one square yard of surface and is heated to the boiling point in 20 or 30 minutes. This solar cooker is now to be manufactured on a large scale and should be effective in avoiding the use of scarce fuel, particularly in the many arid regions.

More ambitious and designed to produce power for small steam engines or electric motors is a solar heater devised in his spare time by Mr. A. L. Gardiner, who is working at the National Physical Laboratory of India as Unesco adviser on scientific translation services.

ONE MAN EFFORT

To convince a sceptical world of the immense practical value of his invention, Mr. Gardner designed and built a plant on the roof of his New Delhi flat during last summer.

Costing less than £7 for materials and constructed single-handed by the inventor using a dining-room chair as his work-bench, this plant concentrates the sun's heat from an area of 30 square feet into a fixed hot patch of less than one square foot, where it can be used for boiling or distilling water, raising steam and many other purposes.

With his home-made plant completed, Mr. Gardner gave a demonstration of its operation to a leading Indian scientist, Dr. S. S. Bhatnagar, who is director of the Indian Council of Scientific and Industrial Research. Dr. Bhatnagar immediately offered the inventor facilities for erecting further plants at the National Physical Laboratory, and the first of these has now been constructed and is undergoing tests.

The new method uses large numbers of cheap flat glass mirrors to concentrate the sun's heat.

Each mirror is mounted individually on its own small mounting consisting of a pair of hinged bars, one of which is kept pointing at the sun by a common frame that links up a whole group of mirrors.

This makes it possible to tilt all of the separate mirrors in a group by a single control lever, so that they all reflect the sun's rays into a single focus of about the same size as one mirror.

By using a number of these groups all directed at the same focus, the apparatus can be made to give a very large concentration of heat at the focus, equivalent to several hundred kilowatts of energy, and could without difficulty produce temperatures as high as 1000 or 1500 deg. C (1800-2700F).

CHEAP POWER

Heat in such quantities is directly suitable for many industrial processes and could also be used for generating power on a moderately large scale. The cost of the apparatus is so low that the savings in fuel will, according to the inventor's calculations, pay for the installation in the course of a few months of operation.

The plant now being tested at the National Physical Laboratory of India has been designed by Mr. Gardner to give three or four kilowatts of heat energy at a temperature of about 500 or 600 deg. C (900-1000 deg. F.). A simple automatic control, worked by the sun itself, will enable it to follow the sun's movement throughout the day.

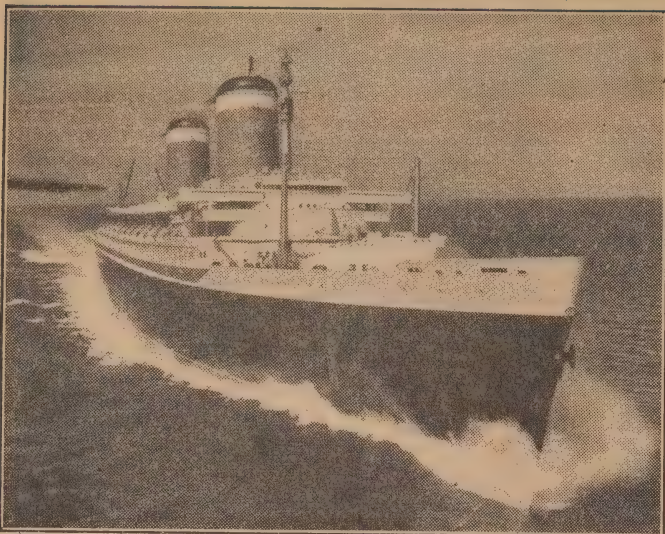
With a total reflecting surface of nearly 50 square feet, it has a heat-gathering power equal to that of a parabolic reflector eight feet in diameter, although its cost of construction is only a small fraction of that of such a large curved reflector.

The third important invention, unlike Mr. Gardner's, is not yet practical but is an entirely new approach to the problem because it generates electricity directly from the radiant energy of the sun, without transforming it into heat. This "solar battery" was demonstrated by the Bell Telephone Laboratories at a meeting of the National Academy of Sciences in Washington, DC, on April 26, last year.

LABORATORY MODEL

In its first laboratory stage the battery consists simply of very thin strips of specially prepared silicon, about the size of safety-razor blades. Silicon is a semi-conductor of electricity and is related to germanium which is now used in most "transistors". On exposure to sunlight, a small current is generated by the silicon and was used in the demonstration to provide power for the transmission of voices over a telephone wire and, through a

(Continued on Page 112)



Racing across the Atlantic at almost 36 knots, the 53,000 ton liner United States, wrested the Blue Riband from Britain's "Queen" ships. The performance of the United States is in no small measure due to the substitution of aluminium alloys for the traditional steel.

therefore possible that the iron first used was that contained in meteorites which fall on the earth from outer space.

This latter is really an alloy of iron and nickel but it was sufficiently like iron to enable man to recognise the latter when he built a furnace against an iron-ore bank and accidentally smelted iron from the ore.

This Iron Age was perhaps the most important of all, as it ushered in an era which made possible the manufacture of the machinery we use today.

So it is that the art of working with metals and alloys is almost as old as mankind. It is the vast increase in modern technical development which has further increased the usefulness of metal.

The most abundant metal in the earth is aluminium. It is never found as a metal but is always contained in a compound, either as silicate or an oxide.

LAST CENTURY

Aluminium was first isolated in 1827. In 1855 a bar of it was exhibited at the Paris Exposition whereupon Napoleon III hit upon the idea that its use would lighten the weight of the implements carried by his soldiers. With characteristic forthrightness, "Boney" got the backing to have aluminium made on a commercial scale but only man-

PROGRESS DEPENDS ON METALS

The increased efficiency of modern machines has been made possible by the use of new metals which withstand the forces of heat and friction to an extent previously undreamed of.

TO speak of new metals may seem odd against the fact that, of the known chemical elements, 60 of them are metals, many of which have been known for centuries.

The new metals we speak of are really mixtures, known as alloys. Copper, iron, cobalt, chromium, tungsten, molybdenum, magnesium, aluminium, nickel, vanadium, titanium, cadmium, are some of the most important metals used for alloys, together with non-metallic elements such as carbon and manganese.

COPPER FIRST

The first metal to be used by man was copper. It occurs freely in nature as the actual metal. Man first used it to make weapons. Having found a piece of native copper he could readily see that it could be bent, hammered, and worked into all kinds of shapes. As his thoughts no doubt were centred on cracking the skull of a rival chieftain, he quickly used the metal to make spears and axes.

However, copper is soft, and no doubt, the thick skulls of the chieftains often merely bent the metal. It thus became more useful for making cooking utensils and ornaments.

Then some enterprising native discovered that the addition of a small

amount of tin made the copper much harder and stronger than either tin or copper separately. Thus was ushered in the Bronze Age, an age recognised by archaeologists as a very important one in the history of mankind.

To scientists, this age was important in that it represented the earliest known period when man made use of an alloy.

by Calvin Walters

From then on the cracking of skulls was a simple process, the magnitude of the success depending only on who used the largest and sharpest and heaviest bronze weapons, and who had the "king hit".

From the Bronze Age man entered the Iron Age. Iron is abundant in the earth as an ore, but is comparatively rare as a native metal. It is

aged to get a small amount. In 1859 the world production was two tons!

In 1886 a revolutionary approach was discovered for making aluminium by an electrolytic process. This has so increased production that the annual world production is now well over a million tons.

Just prior to the first world war, a process was discovered in Germany for making an alloy called duralumin. This is an alloy made from aluminium with the addition of 4 pc copper, 1 pc magnesium and 1 pc manganese. When this is heated, quenched in cold water and aged for several days, it produces a metal which, while retaining almost the lightness of aluminium, is as strong as steel. In a modified form this metal is used today in most of our aeroplanes.

Lighter than aluminium is the metal magnesium. It is lighter than aluminium by about one-third. Being inflammable, it is rarely used except as an alloy. A typical alloy is that called Dow metal, consisting of a mixture of 92 pc magnesium and 8 pc aluminium. This metal is stronger than magnesium and is highly resistant to corrosion.

Iron is still the most important metal of all and the many alloys of the metal have produced an amaz-

ng variety of products. Steel is, of course, the most valued product, being a mixture of iron with a small percentage of carbon.

In order to produce an iron alloy resistant to corrosion, experiments were made with the addition of the metal chromium, that gleaming metal used today to cover a motor car!

To be stainless, steel must contain not less than 12 pc of chromium. A still greater percentage of chromium is sometimes used to produce heat-resistant steel and steel containing 20 pc chromium can be heated to 2000 degrees Fahrenheit without oxidising.

The most popular alloy used today for stainless steel is one containing 18 pc chromium, 8 pc nickel and the remainder iron. This is called "18-8" alloy.

CHANCE OF ERROR

The "discovery" of an alloy is a very laborious matter for often an infinitesimal amount of impurity or a small percentage extra of the additive metals will produce results of wide divergence.

The addition of manganese to iron increases the strength and offers great resistance to cutting. An obvious use for this metal is for the bars of jails and this is just where it is used, much to the chagrin and annoyance of the residents.

Manganese is always used in steel manufacture because of its ability to nullify the effects of sulphur which is always present in iron. If manganese is not added to the iron "brew" the sulphur chemically unites with the iron, forming iron sulphide in the metal grains and thus weakening the metal.

Tungsten is a very valuable metal for the making of special steel alloys, particularly those where hardness is important, such as in cutting and grinding tools. It has been found that cobalt, chromium and tungsten alloys in which iron was present, even as an impurity, were the hardest. This alloy is known as stellite.

Tungsten steel is so hard and durable that it is possible to run cutting machines so fast that the tungsten steel tool gets red-hot without losing its edge.

HIGHER TEMPERATURE

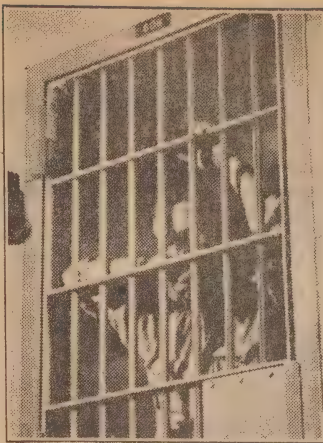
Better still is an alloy known as carbonyl, an alloy of tungsten and carbon. This alloy can be heated to 1500 degrees Fahrenheit without damage to its efficiency.

An interesting sidelight is the method used to prospect for a tungsten ore called scheelite. When ultra-violet light shines upon this ore, it glows with a greenish fluorescent light. A portable ultra-violet lamp has been developed. Prospectors work by night in likely places, shining the invisible ultra-violet light on to the rock formation. The presence of scheelite is revealed by the greenish glow.

The metal molybdenum is also used as a substitute in making steel alloy for cutting tools.

An interesting development in metallurgy in recent years is the process known as powder metallurgy. The process is used for the making of small parts.

The machine used for the process



If you can't cut your way out, mate, blame the metallurgist who compounded those abrasion-resistant steel bars.

is akin to a pill-making machine used in the medical business.

Powdered metal is used and this is often derived from the grinding or shavings from lathes and grinding machines.

Dies are made to the shape of the required article, say a small cog wheel or an electrical contact. The powder is inserted into the die and the machine exerts a pressure of

up to 100 tons per square inch.

It is necessary to bind the metal particles together and this is done merely by the application of heat which by some magical process binds the metal particles solidly together.

The heat used is below the melting point of the metal and this heating causes shrinkage of the metal part. This is easily controlled, however, by making allowance in the size of the die in the first instance.

The great advantage of powder metallurgy is the time it saves by eliminating the necessity for machining the part afterward.

Powder metallurgy is used to make certain types of bearings. This process allows of the combining of such substances as copper and graphite. They can be made very dense or they can be made porous.

Porous metal bearings soak up oil. Thus a bearing of this type can be made to soak up so much oil that it can be sealed away and never needs further attention. These bearings are used in electric refrigerator units and small electric motors.

MANY IMPROVEMENTS

Powder metallurgy is also used to make the modern permanent magnets used on loud speakers.

Permanent magnets were at one time made from an alloy of carbon steel. Later it was found that carbon-free alloys were more efficient.

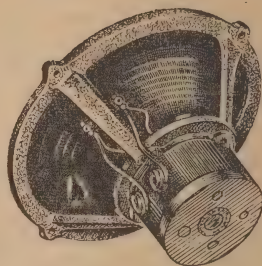
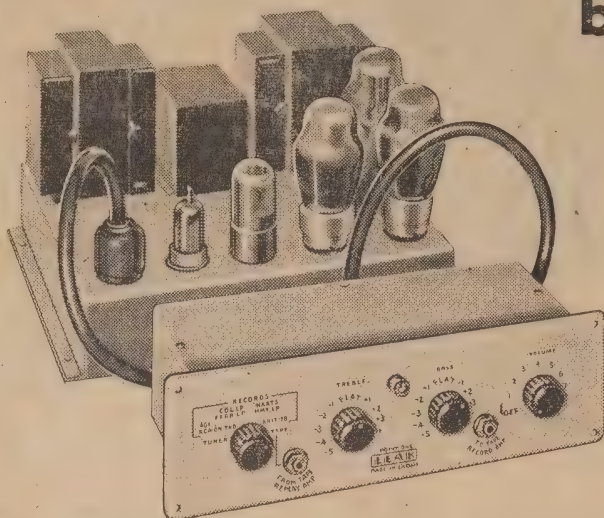
At first chromium was added to the steel with some improvement in the power of the magnet.

Then a further improvement came about with the use of tungsten alloys.



One of the fastest fighter planes in service, Australia's Avon Sabre depends entirely on the use of light, strong alloys in the airframe and modern, heat-resistant metals in the jet motor.

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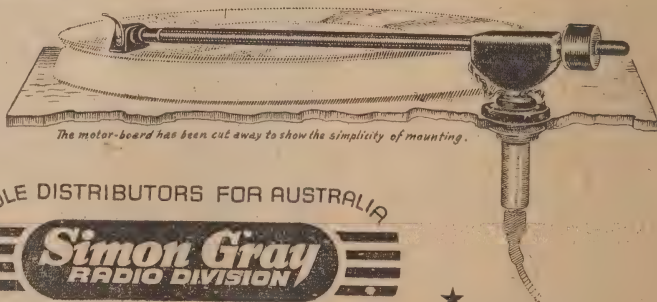
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WORLD'S FASTEST SPEEDBOAT?

In 1923 a Japanese metallurgist made steel with cobalt added and the race for better and better magnets was on.

The old carbon steel magnets could just about lift their own weight. The Japanese cobalt magnet could lift twice its own weight. Then came a mixture of aluminium, nickel and cobalt known as Alnico. This could lift two and a half times its own weight.

The next advance was the discovery that the alloy could be heated and then cooled in the field of a strong electro magnet. This, with the introduction of more cobalt produced a magnet which could lift 18 times its own weight.

WIDELY USED

This was known as Alnico V and is in extensive use today for a number of purposes.

It is a well known phenomenon that a magnet has two poles called North and South pole. It is also well known that like poles attract and unlike poles repel. It is this principle which makes the electric motor possible.

With ordinary steels it is only possible to have one north pole and one south pole in a magnet but with the Alnico magnets it is possible to have a second set of poles at the centre.

It is now possible, in fact, to have magnetic gears making use of this characteristic of Alnico magnets. These gears have no teeth and work something like the following: Discs of Alnico are magnetised with two four or six poles around the edge. If these are mounted on an axle very close to each other but not touching and one is revolved the others will follow suit, because unlike poles of each disc will attract each other.

The characteristic of a magnet where like poles repel is made use of in several ways. One is used in the sheet metal industry for the separation of sheet steel. A strong permanent magnet is placed on each side of a stack of sheet steel at the edges. This causes a magnetisation of the steel and the action of the like poles repelling lifts each sheet of steel and suspends it in mid air from where it can be easily seized by the operator for further treatment.

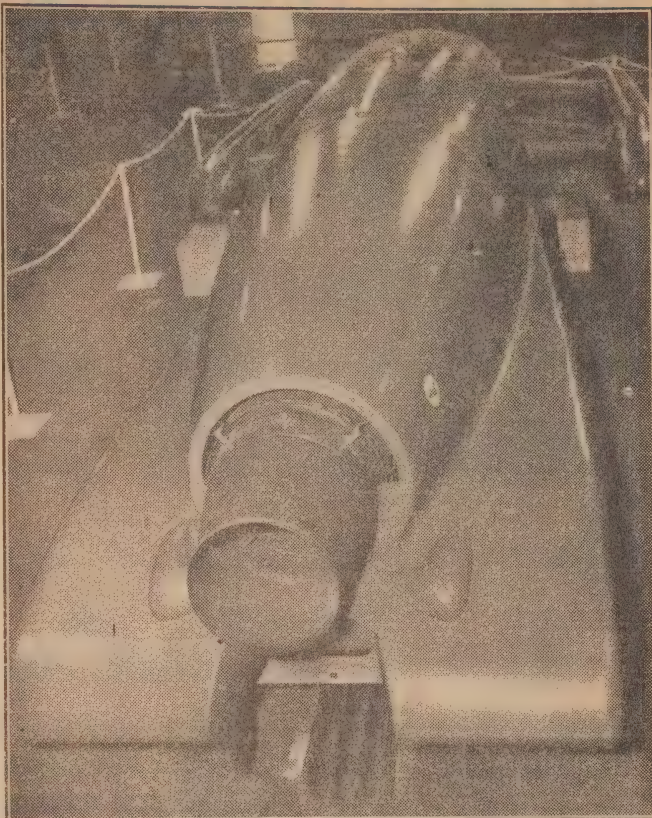
FALSE TEETH

Another ingenious application is rather amusing but it should lead to greater comfort for all those who suffer from loose false teeth.

There must be nothing more disconcerting than to have ones teeth embedded into a bone in the restaurant, only to find that you have inadvertently removed them with the last chew and left them grinning at all and sundry from the plate on the table.

Many methods have been devised for sticking them in, such as the use of suction cups and the application of glue.

The modern method is to use permanent magnets. Small magnets are embedded in the teeth at the upper and lower molars. The magnets are arranged with like poles opposed to each other. The result is that the repelling action of the magnets push the upper and lower set of teeth in



A rear view of the new jet-powered speedboat "Blue Bird", completed recently at the Samlesbury Engineering Works, in England. Measuring 26ft in length, the craft is not unlike a wing-less aeroplane, with its light alloy hull and mainframe of tensile tubular steel. Weighing $2\frac{1}{2}$ tons, it is powered by a Metropolitan-Vickers "Beryl" turbo-jet consuming 650 gallons of fuel an hour. Several months will be spent in collecting high-speed data, after which Mr. Donald Campbell, son of the late Sir Malcolm, will attempt to recapture the world's water-speed record.

opposite directions, the upper teeth up and the lower teeth down. The opposing force is about five ounces with the jaws closed.

There should be an idea in this, with the magnets set the other way, so that the attraction would keep the jaws closed.

These teeth would then be ideal for women, politicians and other "ear bashers".

With the development of the gas turbine and jet engine grew the need for metals which would stand the stresses of extreme temperatures. Without this metal the jet and gas turbine would be impossible to maintain.

So far the greatest success has been with chromium, iron, molybdenum alloys. Two such alloys contain 60 pc chromium, 25 pc molybdenum 15 pc iron; secondly 60 pc chromium 25 pc iron, 15 pc molybdenum.

It will be seen that chromium is

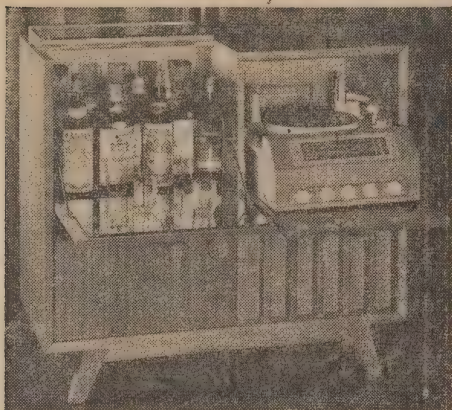
the major constituent of these alloys, although another alloy contains 16 chromium, 25 nickel and 6 molybdenum alloy steel.

These alloys must work at temperatures exceeding 1500 degrees Fah, without oxidising, warping, melting or cracking.

Great care must be taken in the manufacture and the process includes melting and pouring in vacuum to avoid formation of oxygen, nitrogen and other gases and compounds in the metal. The alloys are expensive but so are the planes. Lives are more valuable than the machine and any defect in the metal could be disastrous.

The alloy of chromium, nickel and molybdenum steel promises to be a super alloy for the making of dies for die casting in brass. If it is successful it will be a revolutionary metal for this purpose.

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Technical Review

UHF BOOSTER CARRIES TV OVER RANGE OF HILLS

RCA scientists and engineers have helped television to climb over a range of hills into Vicksburg, Miss., in a successful test of the world's first "booster" station designed for ultra high frequency (UHF) TV operation.

FOR six weeks during the summer,

TV viewers in a major part of Vicksburg were able for the first time to receive clearly the programs telecast by station WJTV, in Jackson, Miss. Although Jackson is only some 35 miles east of Vicksburg, most of Vicksburg is shielded from the station by a ridge of hills which has interfered with UHF reception.

The problem made Vicksburg a suitable test area for RCA scientists who have been engaged for some time in a program to find methods of increasing the strength of UHF signals under these conditions.

Operating under temporary authorization from the FCC, the RCA team conducted the tests after surveying the area to determine the most suitable location for the specially-designed UHF booster equipment.

The booster operates by picking up the signal from the broadcasting station on a receiving antenna, amplifying the signal, and retransmitting it on the same channel by means of an antenna directed toward the required area.

The concept is not new, but it has not been done previously with equipment capable of handling UHF signals.

The field tests, made under actual



The receiving antenna of the RCA experimental UHF booster station, photographed at Princeton. It was later shipped to Vicksburg for a successful six-week trial. Its highly directional qualities, coupled with those of the transmitting aerial, minimize feedback problems around the booster amplifier.



operating conditions, showed:—

1. That station WJTV received an effective increase in its power by 200 times in the "shadowed" area of Vicksburg through the coverage pro-



vided by the booster system.

2. That the experimental RCA UHF booster transmitter, with power of only about 10 watts, provided acceptable service in an area partially shadowed by intervening terrain.

3. That a good engineering estimate of the effective radiated power needed to establish a given grade of UHF service can be made once the topography of a specific television service area is known.

The Vicksburg test area, the RCA scientists found, needed an effective radiated power of 1000 watts for adequate coverage. The required power was obtained by use of a special transmitting antenna with a gain of 1000 and a booster power of 10 watts.

The RCA UHF booster system is built around a low-power auxiliary transmitter, a highly directional receiving antenna system, and amplifying equipment.

At the test location, the receiving antenna was mounted on a water tower about 110ft above the ground, and the transmitting antenna, directed into the shielded area of the city, was set on a wooden tower 100ft away.

TUBELESS TELEVISION SETS

ADDRESSING a recent meeting in Chicago of the NBC Television Affiliates, Brig. General David Sarnoff, RCA Chairman, made this prediction:—

"I believe that at some time in the future—I will hazard a guess and say five years from now—no tube will be needed in a television set—not even the picture tube. Then all the debates about one-gun and three-gun tubes, rectangular and round, glass and metal, shadow-masks, and focus-mask, and other kinds of masks, will belong to the language of the past.

"By "Electro-Luminescence we shall have a screen on the wall of whatever size you wish to make it—small or large—and that screen will be connected directly by a small cable, with a little television box—about the size of an average cigar box that can be placed anywhere in the room. No cabinet will be required; and if desired, screens can be placed in every room of the house.

"The television box will contain the tuning and volume controls, and the station selector. It will also have a remote control knob enabling one to make the picture of any desired size; to have it either in black-and-white or in color; and to make it brighter or dimmer. All these features will be easily adjustable by the viewer, to suit his individual taste.

"Transistors will replace the present small tubes, and an electro-luminescent screen will take the place of the present cathode-ray tube."

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Super 8in CS

For refined quality up to 4 watts, or for use as Middle or Treble Speaker with cross-over network. £12/2/10.

Super 8in CS/AL

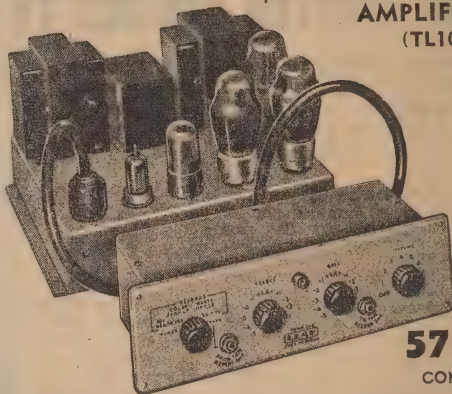
An outstanding Treble Unit with aluminium speech coil and response maintained up to 20,000 c/s. This model is recommended for use in twin-speaker systems. £12/14/1.

Wharfedale 12in/CS

The 12in/CS makes a very good bass unit with suitable reflex loading and a cross-over between 400 and 3000 c/s, and is the "next best" to the Wharfedale 15in/CS. £24/19/-.

Wharfedale 15in/CS

This speaker is designed for smooth response between 25 and 2000 c/s, with heavy cone and long speech coil. It is the ideal speaker for cross-over networks. When provided with 8 or 9 cubic feet of air loading the cone resonance is below 25 c/s. £41/4/8.

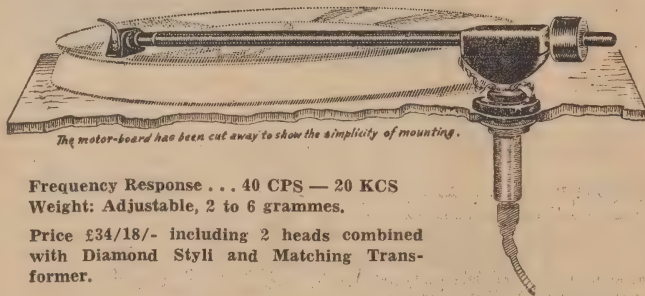


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The motor-board has been cut away to show the simplicity of mounting.

Frequency Response . . . 40 CPS — 20 KCS
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A NEW TYPE TRANSISTOR UNIT--THE PHOTOTRANSISTOR

The amazing transistor has invaded the realm of the vacuum tube and, in a short span of time, shown that it will soon become the most important factor in electronics. In radio, television, computers, counters, and many other phases of electronics, it has brought us promise of space conservation, power efficiency, and design simplicity.

AN important adaptation of the transistor, the phototransistor, shows even more immediate promise of being used in the industrial field. Besides having all of the advantages of the transistor, it is the most photosensitive device yet produced because of its current-amplifying characteristics.

Photosensitivity has been an important part of automatic equipment for many years. It has been used extensively in automatic "on-off" devices such as automatic door openers, counters, keyers, light dimmers, and other applications.

Up to now, the ordinary phototube has enjoyed a monopoly in photosensitive equipment. But it has the disadvantage of supplying only small amounts of photosensitive

only two contacts whereas a comparable transistor has three.

During the early manufacturing stages, when the transistor is not yet photosensitive, it has all three contacts. However, after power has been applied to the emitter contact, and the emitter surface has become photosensitive, the contact is removed (Fig. 2).

The photosensitive surface at the emitter is usually only .01in in diameter. Because of this a lens is used to focus the light source on the sensitive area.

LIKE TRANSISTOR

The phototransistor operates on the same principle as an ordinary transistor. The two are compared in Fig. 3. In the ordinary transistor, the resistance of the collector-base circuit is determined by the electron flow in the emitter-base circuit. When a positive signal is applied to the emitter, as shown in (a)' of Fig. 3, the emitter electron flow increases, causing a corresponding drop in collector-base resistance and an increase in collector current.

In the phototransistor, the resistance to the flow of collector current also depends upon the status of the electrons in the emitter.

However, since there is no complete circuit to provide for emitter current flow, the collector-base resistance is dependent on electron agitation in the photosensitive emitter area. Thus, when a light beam strikes the photosensitive emitter (b of Fig. 3), the resultant agitation of the electrons in the emitter reduces the collector-base resist-

The load resistance of the relay is an important item to consider because of its limiting effect on the current flow. Thus, it is advisable to use a higher supply voltages with higher relay resistances.

Although the phototransistor has not yet been perfected, and is rela-

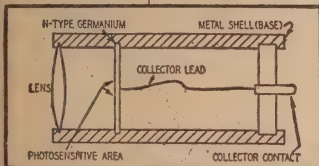


Fig. 1. The construction of the phototransistor is shown here. Note the small area and the lens used to concentrate the light onto this area for maximum efficiency.

current. Amplifiers have to build up these small variations to a high enough value to operate the automatic equipment.

The phototransistor, on the other hand, can supply enough current to operate a relay directly. (Phototubes deliver microamperes; phototransistors deliver milliamperes.) Because of this characteristic, the phototransistor requires less complementary equipment and is more efficient.

NOT NEW

The phototransistor is not exactly new, in the strictest sense of the word. Some companies have spent the last couple of years constantly improving the phototransistor. Western Electric, pioneers in transistor construction, developed the first piece of phototransistor commercial equipment for Bell Telephone. This was a card translator installed in 1952 as part of a complex nationwide telephone switching system, and resulted in a great saving of space and power.

Like the ordinary transistor, the phototransistor can be made as a point-contact or junction type. The one shown in Fig. 1 is a coaxial point-contact phototransistor.

There isn't too much difference between this point-contact phototransistor and the point-contact transistor; their basic construction is the same except that the emitter contact has been removed so that the photosensitive emitter surface can be used to its fullest extent. Therefore, this phototransistor has

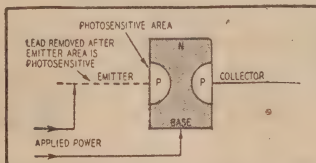


Fig. 2. The phototransistor during manufacture. It is first made as a conventional transistor, the contact on the emitter surface being removed after this area is made photosensitive.

ance. Then the collector current increases.

Another form of phototransistor is the n-p-n junction type, a Bell Telephone development. This type of phototransistor is a light-sensitive device with an incorporated amplifier. The X-25, as it is called, uses the base rather than the emitter, as the photosensitive area.

This phototransistor is capable of operating a relay directly; it can supply an increase of 4 milliamperes or more when light is applied. Of course, sensitive relays that can be energized by these small currents must be used. These have sensitivities of 1 to 9 mA and vary in resistance from 2200 to 40,000 ohms.

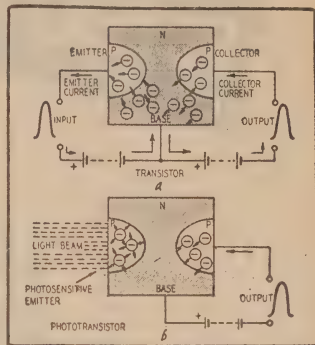


Fig. 3. Comparison between a conventional transistor (top) and the phototransistor (below). In the latter the emission from the photosensitive area replaces the emitter current which is normally varied by the applied signal.

tively high priced, various manufacturers are trying to adapt it to their particular products. Even though it is a high-priced item, the phototransistor will still reduce the cost of equipment using it, because it does not require sensitive amplifiers. Another point to consider is that maintenance costs will be reduced.

TYPICAL COMPARISON

An example of the simplification of circuitry made possible by the new unit is given by comparing a conventional phototube automatic control circuit for opening doors with a phototransistor type unit designed to do the same job.

In the conventional phototube circuit, the phototube is supplied with suitable voltage from the HT system, usually in the order of 90 volts, and this is applied through a fairly high value load resistor. A change in light on the cell will cause a change in current through it, this presenting itself as a change in voltage across the load.

This change is very small and can only be used to change the bias on a following amplifier valve. This, in turn, operates a relay.

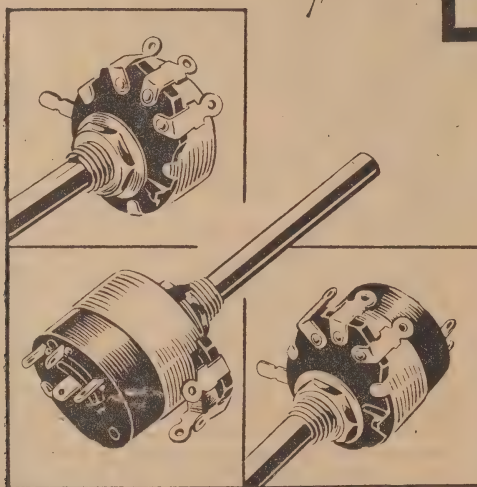
The equivalent phototransistor circuit requires many fewer parts, consisting, essentially, of the phototransistor itself, a battery with potentiometer to operate as a sensitivity control and a relay. The extreme simplicity of such a circuit naturally ensures a high order of reliability.

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NEW APPROACH TO DESIGN OF SPEAKER ENCLOSURES

There is probably no more urgent problem in the whole audio field than the realisation of good bass response from a small-sized speaker baffling system. This rather novel approach is described by E. M. Villchur in a recent issue of "Audio".

VILLCHUR begins by restating his objectives:

1. To keep harmonic distortion low in the region below 70 or 80 cps, particularly at higher power.
2. To keep frequency response uniform and extended at all power levels.
3. To solve these two problems without requiring architectural installations, very large cabinets or critical final adjustments.

Since none of the usual baffling systems seemed to meet all these requirements, the author decided to follow a different line of investigation.

The speakers themselves were open to some query and it was noted that a harmonic distortion content of between 5 and 10 pc was readily tolerated in the range below 60 cps, even with good quality speakers. This seemed inconsistent with the very great efforts made to keep distortion low elsewhere in the system.

SUSPENSION SYSTEM

Much of the distortion, according to Villchur, is traceable to non-linear movement in the speaker cone assembly. The cone edge support and central "spider" have the responsibility of supporting the cone accurately in the framework and returning it, after each excursion, to a central position.

While this is a very necessary function, the resistive force of this elastic suspension tends to increase as the amplitude of movement increases, introducing a non-linear component into the output. It seemed a logical step to reduce the influence of the mechanical suspension, if at all possible, and find other means to control the cone movement.

This led naturally to the thought that use could be made of the air behind the cone.

In general, the air behind the cone, or the back wave, has hitherto been regarded as a necessary evil, which may variously be wasted, suppressed, confined or pressed into some kind of service. Perhaps, Villchur reasoned, it could be worked into the scheme of things.

"INFINITE BAFFLES"

When a speaker is mounted in an airtight box—a so-called "infinite baffle"—the volume of air trapped behind the speaker cone has an important bearing on the reproduction.

If the volume of the box is very large, say at least 10 cubic feet, then the bass characteristics of an ordinary speaker will not be greatly upset. Its bass resonance, normally around 50 cps, will remain largely unaffected.

However, decreasing the volume of the box in the interests of convenience, gradually raises the effective resonance of the system. It does this because the job of compress-

ing and rarefying the limited amount of trapped air within the box introduces a significant "stiffness" component, which is additional to the stiffness of the suspension.

The result of this is very undesirable, because it produces a resonance too high in the range and seriously restricts the response below the resonance. The truth of these statements is readily demonstrated if an ordinary speaker is mounted in a small "infinite baffle".

Viewing the whole situation, the author reasoned that it may be possible to start with a loudspeaker having a very low fundamental resonance and allow the air loading in a small box to raise it to somewhere around about 45 cps.

SPEAKER UNIT

The idea would be to design a speaker with more or less conventional figures of mass but reduce the elastic stiffness of the supporting mediums to about 10 pc of the amount which would normally be provided. This would drastically lower the bass resonance—say to about 10 cps—and render the speaker completely unsuitable for use in any conventional baffling system.

However, when mounted in a small enclosure, as envisaged, the

air loading on the rear of the cone would provide the missing 90 pc of the elasticity and restore the resonance to a conventional figure. It would do so, however, without introducing the non-linearity associated with normal cone edges and supporting spiders.

The enclosure becomes, in fact, an integral part of the speaker and the two cannot be dissociated. Either one alone would be completely useless.

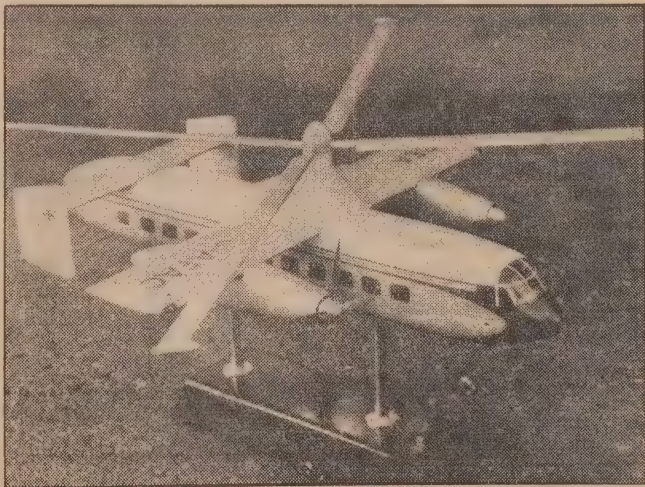
EXPERIMENTAL SPEAKER

An experimental speaker system constructed along these lines used a 12in "woofer" unit, modified according to requirements and an enclosure of 1.7 cubic feet. It was heavily braced and carefully sealed around the joints to preserve its proper characteristics.

Fibreglass padding was added behind loose cheesecloth to lower the "Q" of the enclosure and level off the rise in output near resonance. This internal padding also served to break up internal reflections at the higher frequencies.

The author claims that listening tests showed the "Acoustic Suspension" speaker to compare more than favorably with comparable speakers in other types of enclosure or set into wall spaces.

BRITAIN'S NEWEST HELICOPTER



The latest of Britain's helicopters, seen here in model form, is the Fairey Rotodyne and it can carry forty-four passengers. At the tip of each rotor blade there is a small jet engine. On each wing there is a 3,000 horsepower turbo-prop engine. All this power means that it can cruise at 150 miles per hour. The "Rotodyne" has been developed by the Fairey Aviation Company of Britain from the "Gyrodyne", a twin rotor machine. The makers claim that the Rotodyne will reduce the cost of air travel between city centres to something near the price of a first class railway ticket.

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NEWS AND VIEWS OF THE MONTH

Unique De-icer

ONE of the major problems of all-weather air transport—and one which is becoming increasingly important with the advent of greater speeds and greater heights—is that of ice. To tackle the problem a heater has been developed by Napiers, which uses a unique method of construction.

The difficulties in the design of an aircraft heater system are formidable in the extreme. It must apply the heat on the external surfaces of the aircraft, and not waste energy elsewhere. It must be as light as possible, easily maintained, and as thin as possible, so as not to alter the plane's aerodynamic qualities.

It must have a smooth finish, to reduce drag, and must be applicable to any of the various shapes used on aircraft surfaces. It must resist rain, and be unharmed by temperatures ranging from far below freezing point to those encountered in the tropics.

To overcome the difficulties, and particularly the problem of application to a variety of curved surfaces such as wings, propeller-bosses, &c., Napiers use a spraying process, building up the complete heater layer by layer.

First a layer of insulating resin is applied to the surface to be pro-

tected. Then a metallic electrical conductor is sprayed on in such a way that the resistance is varied to give the desired distribution of heat. For example, more heat is required at particularly vulnerable points, less elsewhere. Terminals are fitted, to connect with the electricity supply, and finally an outer insulation layer is sprayed on and highly polished, to give the smallest possible drag.

The surface finish can be colored as required without affecting its performance.

Some idea of the light weight of this system can be gathered from the fact that at most the heater is one-twentieth of an inch thick. It weighs less than five ounces for each square foot, after allowing for the weight of the terminals.

To protect the heater against the danger of becoming too hot (it can operate safely up to 100 degrees C—the boiling point of water), an automatic cut-out is provided, which both ensures and controls the temperature of the surface.

Australian Invention

INVENTIONS by local scientists are always news, and doubly so when they are of sufficient merit to excite the interest of American manufacturers and to earn much needed dollars. Such an in-

vention is a new spectroscope recently developed at the CSIRO.

Mr. Alan Walsh, of Melbourne, invented it.

A spectroscope analyses colors and images in light, playing a key role in an important branch of physics.

Mr. Walsh is a scientist and industrial chemist of the CSIRO.

A leading American manufacturer of scientific instruments has taken up this new spectroscope.

It has an ingenious modification which gives better results when applied to existing spectroscopes.

It helps research into metal production, farming, coal, petroleum technology and many other fields.

The new technique has assisted the Royal North Shore Hospital, Sydney, in blood pigment research.

This Australian spectroscope gives scientists a far better instrument for a wider variety of investigations than ever before.

Cheap Kilowatts?

THE question of whether atomic power will ever compete, economically, with coal and other fuels, is one which may not be settled for a long time, but some idea of the shape of things to come is contained in a report from the United States Atomic Energy Commission.

This announces a recent development which, it is claimed, could

POPULAR SCIENCE QUIZ

Q. How do flies become DDT-resistant?

A. The secret of how flies have become resistant to DDT and other modern insecticides has been discovered by Clyde W. Kearns and co-workers at the University of Illinois.

The flies make their own antidote to DDT and presumably to other insecticides. They do it by developing enzyme chemicals. One called DDT-dehydrochlorinase changes DDT to the nontoxic compound, DDE.

This enzyme antidote is specific for DDT. Flies apparently produce another enzyme antidote for other insecticides such as chlordane.

From a million or more flies, Dr. Kearns and associates were able to get enough of the anti-DDT stuff to study it. They hope to purify it, find out the precise mechanism of the DDT detoxifying process and then, presumably, find a way to circumvent the antidotal enzyme.

This is planned to occupy a five-year research program.

Q. How can the country of origin of opium be detected?

A. It has been discovered that the place where raw opium was grown can be determined by chemical analysis of the ash when the opium is burned. Indian opium, for example, has high potassium and low calcium content in the ash. Turkish opium,

on the other hand, has a high calcium and low potassium content.

Knowing the source of opium should help tighten control measures and suppress illegal production in those areas where the illicit traffic in opium originates.

Opium is produced from one series of poppy plant, Papaver somniferum, but the composition of its ash varies significantly, depending on the geographical origin of the opium. This variation in ash composition depends on varieties within the species and on such local features as soil, climatic conditions, and agricultural techniques.

Canadian scientists, who evolved the method, have now analysed more than 100 opioms from Yugoslavia, Turkey, Iran, India, Indo-China, Korea and China. Tests were made for both major and minor constituents. Opium from Iran appears to have variation due to the processing of the raw opium.

The elements determined are potassium, calcium, phosphorus, sodium, magnesium, silicon, iron, aluminium, titanium, boron, manganese, molybdenum, lead, tin and copper. Spectrographic, colorimetric and flame photometric procedures are used.

Q. What is the closest that Mars can ever approach the earth?

A. If the orbit of Mars and also that of the earth around the

sun were truly circular the approach of the two planets would be a very simple matter. The mean distance of earth from the sun is 93-million miles, that of Mars is 141½-million miles. With circular paths they would always be closest when in the same direction from the sun, the distance being 48½-million miles, the difference between 141½-million and 93-million.

When on opposite sides of the sun, Mars and earth would be farthest, separated by 234½-million miles, the sum of their individual differences from the sun.

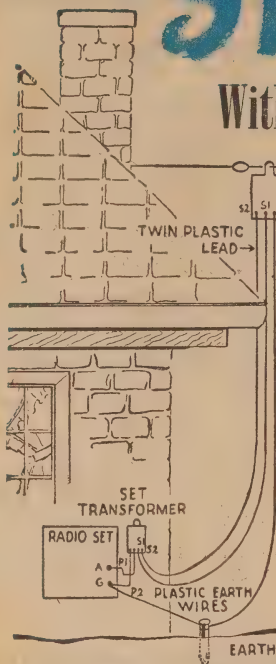
The orbit of the earth is nearly circular. On July 3 we are farthest from the sun at a distance of 94½-million miles, which is 3,152,000 more than on January 2. The orbit of Mars is considerably more lopsided, for that planet varies about 26-million miles in distance from the sun.

At the closest approach of these two orbits they are only 35½-million miles apart. Every year, about August 28, the earth reaches the part of its path nearest that of Mars, but it rarely happens that Mars is there at the same time.

It happened in 1924, and then Mars was less than 35-million miles away, closer than it will be for centuries. The year 1939 brought the next close visit, with a distance of 36,171,000 miles. July 2, 1954, was also close, but in September, 1956, it will be still better, with 35,400,000 miles, almost as good as 1924.

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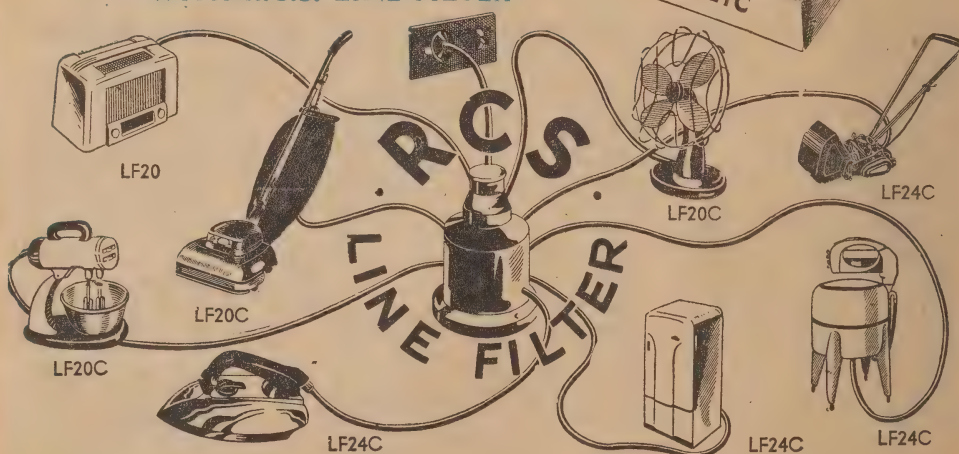
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The scheme is based on the breeder reactor, not a new idea in itself, whereby non-fissionable fuel is made fissionable in the atomic pile. Up until now non-fissionable varieties of uranium have been used to supplement the rarer fissionable types.

The latest scheme is to use thorium in place of the rare non-fissionable fuels and which appears to be just as suitable. What is more important is that thorium is, relatively, plentiful, being something like 10 times as plentiful as uranium.

Extracted from monazite sand it is found in Brazil, India, Indonesia, Malaya and Ceylon. The United States alone has deposits, but of a lower grade.

Wot, no Martians?

A SCIENTIST shattered the illusions of hundreds of school-children when he told them it would be long before space ships could go from one planet to another.

Dr. J. G. Porter, Chief Scientific Officer at the Royal Observatory, said nobody yet had been able to gauge how speed could be measured in space or how space travellers could tell which way they were flying.

"What would probably happen would be that a space-ship would turn over and over as it went along."

A trip to the moon could possibly be directed by radar, but once a space-ship went beyond the moon to other planets, entirely different problems would arise.

A trip to Mars would probably take about eight months, Jupiter three years, Saturn seven years, Dr. Porter said.

A schoolboy asked him if he thought Martians were responsible for flying saucers.

"So far as I know flying saucers do not exist except in the imagination of scientific authors," Dr. Porter replied.

"I do not believe in them at all."

Airborne TV again

THE problem of long distance TV relays has yet to be solved on an economical basis, but the use of an airborne relay station appears to be justified when the program is of sufficient importance. Such an event was a recent World Series baseball match staged in Florida and watched by Cuban baseball fans 200 miles away.

The televised game was clear with only minor flickers despite winds and a heavy thunderstorm during part of the program.

Cubans, who rank baseball as by far their most popular sport, watched the game on sets in homes, stores and hotels. This was the first time they had seen a live TV program originating in the United States.

The plane, equipped with specially built receiver and relay transmitter, flew almost directly south of Miami's Station WTVJ, which was transmitting the game.

Only the picture of the game was received. A commentator listening with earphones to a shortwave broadcast from New York gave a running account in Spanish.

Radio, TV and Hobbies, February, 1955

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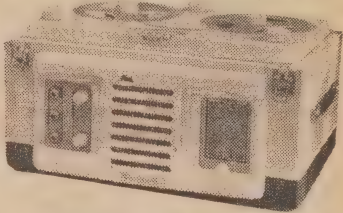
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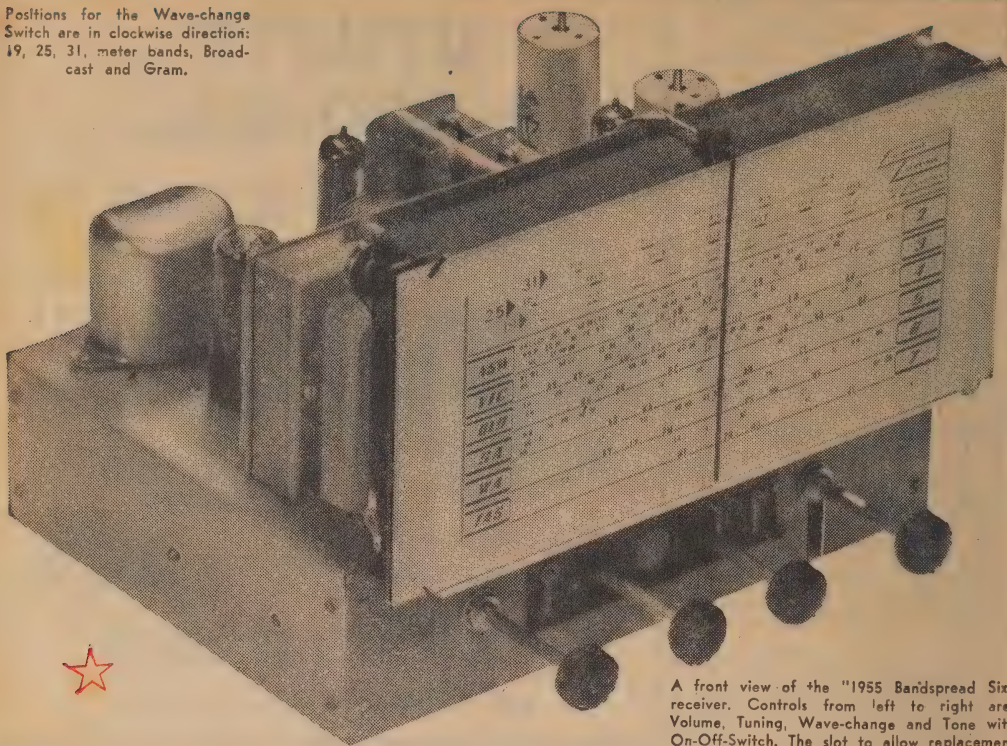


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Positions for the Wave-change Switch are in clockwise direction: 19, 25, 31, meter bands, Broadcast and Gram.



A front view of the "1955 Bandspread Six" receiver. Controls from left to right are; Volume, Tuning, Wave-change and Tone with On-Off-Switch. The slot to allow replacement of the volume control's clearly visible.

BANDSPREAD WITH R-F STAGE

This month, we are able to present still another multi-band receiver featuring, on this occasion, an RF stage and bandspread on the shortwaves. With its added gain and selectivity, it should be an ideal set for those who want to keep track of programmes from their former homeland.

DURING the past couple of years, there has been a distinct renewal of interest in the short waves and, in particular, on the main international shortwave bands.

However, would-be listeners to these overseas programs are often deterred by the fact that, on the average receiver, stations are difficult to tune and identify. This is due mainly to the very wide range of frequencies which fall within the tuning range of the average dual-wave receiver.

PROBLEMS

Commercial receivers with bandspread, which makes tuning comparatively easy, are neither numerous nor cheap. Then again, up till recently, home construction of such sets has presented considerable difficulties for the not-so-experienced enthusiast.

With the arrival on the market of complete, pre-aligned tuning units, the position has been much improved from the home-constructor's point of view.

Provided he can cope with the ordinary mechanics of set construction and wire up an IF and audio system, the multi-band feature presents no problems at all. If anything, it is quicker and easier to instal than an ordinary set of broadcast coils.

The unit simply has to be bolted in position, a few external leads connected up and it is ready for operation. In most cases little or no alignment is necessary, apart from touching up the IF transformers.

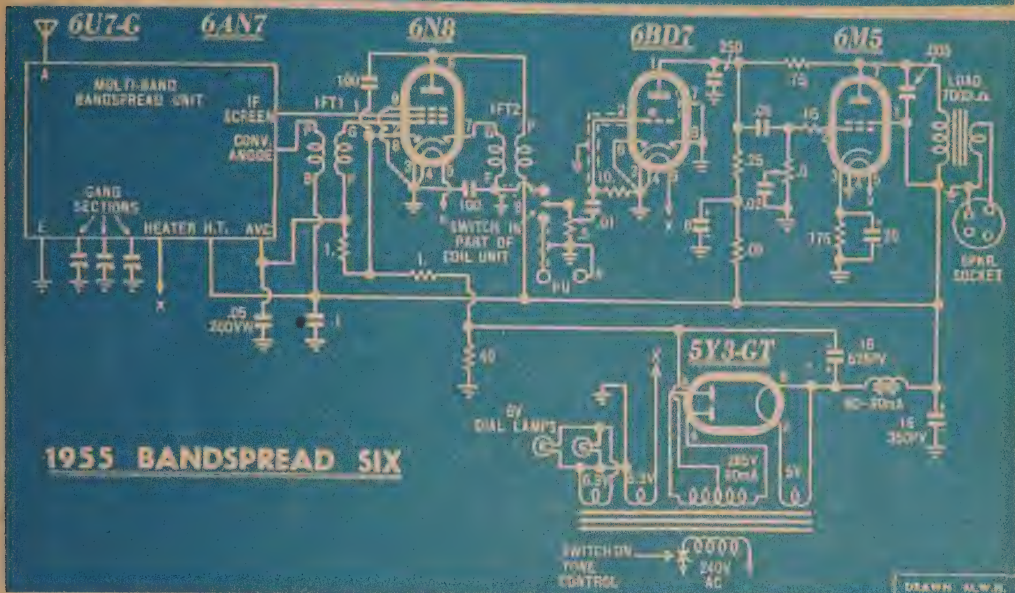
PREVIOUS DESIGNS

You may remember that we described a bandspread receiver in the November issue last, followed in December by a general-coverage receiver, both using newly released tuning assemblies. In those two issues we went to some pains to explain the difference between the two approaches.

Both receivers were well received but there was a natural tendency to speculate about a set using bandspread (as per the November issue) and an RF stage (as in December). Such a set might cost a trifle more but would certainly perform very

by
L. Varady

CIRCUIT DIAGRAM OF NEW BANDSPREAD RECEIVER



The circuit is basically the same as previous designs using self-contained tuning units. General behavior of the set is similar to the 5-valve model in the November issue, except that the RF stage would give a little extra "lift" on weak signals.

well on the major international broadcast bands.

Anticipating such a demand, the manufacturers of the bandspread unit (Kingsley) have come to light with a new, enlarged tuning unit, carrying an RF stage.

Externally, it looks very like the smaller unit, being much about the same width and height but a little longer. It covers precisely the same bands, namely broadcast, 19m, 25m, and 31m with a position on the selector switch for "Gramo" operation.

CONVENIENT

The similarity between the two units was fortunate from our point of view because it saved us the job of evolving a completely new layout. This is always a problem with "packaged" tuning units, because no two of them ever seem to be the same shape and size.

By making a few modifications to the chassis of the "Four-Band" receiver (November issue), we were able to accommodate the RF-stage unit, without disturbing overmuch the rest of the wiring. Hence the similarity between the original "Four-Band Receiver" and the present one—the "1955 Bandspread Six".

While we intend to issue a special blueprint for the new Bandspread Six, we mention the point in case someone, who has bought the earlier chassis, now wants to use the larger (and more expensive) tuning unit.

Which unit you ultimately buy and which set you build must depend on the age-old formula of

"what you get for what you pay"

Both receivers offer the same facilities and the five valve version will give a good account of itself. As will any other well-designed five-valve set.

There can be no denying, however, that the RF stage will make its presence felt with better gain and selectivity on the weaker stations, both broadcast and short-wave. However, the choice is up to you.

Before discussing the construction of the set, it may be as well to have a look at the circuit diagram. The whole "front-end" of the receiver

is determined by the design of the tuning unit and the details could only be extracted by carefully checking through the wiring.

To extract and show all these details would only complicate the circuit unnecessarily and we have, therefore, merely shown the tuning unit as a box, requiring certain external connections. Most of these will be quite obvious.

Apart from the extra gang section, they are the same as for the smaller unit.

The use of the "veteran" 6U7-G in the RF stage is rather surprising in a unit of recent design because

PARTS LIST

- 1 chassis 12in x 9 1/2in x 3in.
- 1 power transformer, 285V at 0.7 mA, 6.3V at 2A, 5V at 2A.
- 1 60 or 80 mA filter choke.
- 1 Kingsley KBS2 Bandspread coil unit.
- 1 3-gang tuning capacitor.
- 1 dial with glass to suit gang and coil unit tuning ranges. (USI 51.)
- 2 455 Kc IF transformers, Nos. 1 and 2 preferably high gain.
- 1 7000 ohm speaker transformer.
- 3 9-pin miniature valve sockets, 1 octal and 1 4-pin miniature speaker socket and plug.

VALVES

- 1 6AN7, 1 6N8, 1 6BD7, 1 6M5, 1 5Y3GT, 6U7G.

CAPACITORS

- 1 25 mfd 40PV, 1 16 mfd 525PV, 1 16mfd 350PV and 1 8 mfd 350PV

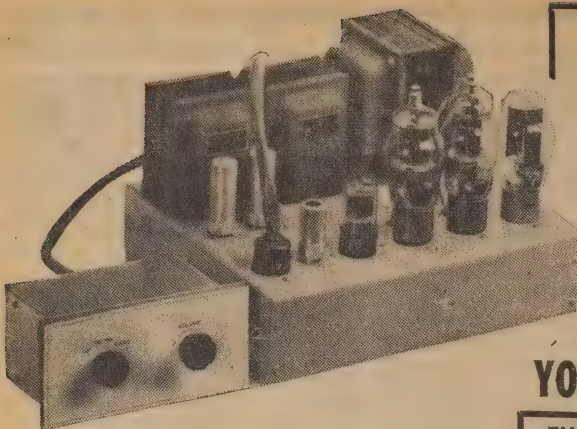
- electrolytics, 1 .1 mfd, 1 .05 mfd, 1 .05 mfd 200VW, 1 .02 mfd, 1 .01 mfd, 1 .005 mfd, 1 250 mfd, 1 250 pf, 2 100 pf.

RESISTORS

- 1 10 meg. 1/2w, 3 1 meg. 1/2w, 1 .75 meg. 1/2w, 2 .5 meg. potentiometers (long shaft), 1 .25 meg. 1w, 2 .05 meg. 1/2w, 1 175 ohm 1/2w, 1 40 ohm 1/2w.

SUNDRIES

- 4 terminals (2 red, 2 black), 4 knobs (to suit cabinet style and tuning), 1 5-tag, 2 4-tag and 1 2-tag mounting strips, 1 1/2 extension shaft, (if necessary) power flex and 3-pin flat plug, 2 6V dial lamps, approx. 4ft shielded hook-up wire, rubber gang-mounting bushes spaghetti sleeving, hook-up wire, solder, solder lugs, nuts, bolts.



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- Advance 51 & 52
- TRF Radiogram
- Super Three
- Simple Superhet
- "The E.P." Triple 6
- Vibragram
- Vibra 5

- Economy 5
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- Wide-Range Tuner No. 2 (455 K.C.)
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of the number of miniature RF pen-
todes available. However, the 6U7-G
is quite a reliable valve and the
manufacturers apparently had a good
reason for using it in preference to
the others. Hence its appearance in
the circuit.

The 6N8 is a standard type and
needs no special comment.

The heater wiring to these valves
is so arranged that one side is con-
nected to the chassis. This makes
it necessary to earth one side of the
supply winding, the other side being
the 6.3V. "active" lead.

One winding should be able to
supply all valves leaving the other
one, if provided, to run the dial
lamps.

INDICATOR LIGHTS

If required, the dial lighting cir-
cuit may be run through spare con-
tacts in the tuning unit switch with
a view to operating "Gramo." indi-
cator lighting.

Other spare contacts can be used
to change the audio system over from
"Radio" to "Gramo" input. The
switch must be coupled to the "hot"
end of the audio volume control as
indicated in the circuit.

Setting the selector switch to the
"Gramo" position also interrupts the
supply to the screens of the first
three valves, thus rendering the tun-
ing section of the receiver inopera-
tive. You will note that the screen
of the IF amplifier connects directly
to the unit, which contains the neces-
sary supply and bypass components.

For the rest, the 6N8 stage is a
perfectly standard IF amplifier-cum-
detector.

The same general remark applies
to the audio system using a 6BD7
and 6M5. Other valves could be
used in these positions but there was
no special virtue in departing from
the five-valve version, merely to be
different.

The power supply did call for a
change, however, if only to be meti-
culous.

Addition of the RF stage does
bring the drain just over the 60-
milliamp mark, so that the trans-
former and choke previously speci-
fied would be overloaded as far as
ratings were concerned.

In practice, both would probably
stand the extra few milliamps with-
out distress and our initial tests on
the set were carried out with the
original transformer still in position.
That's the way it was, in fact, when
the underneath photograph was
taken.

If you have a 60-milliamp trans-
former on hand, by all means try
it. If buying a new one, however,
specify an 80-milliamp type, as per
the circuit.

WATCH THE SIZE

Check the dimensions, when buy-
ing the transformer, as a bulky type
may not fit in too easily.

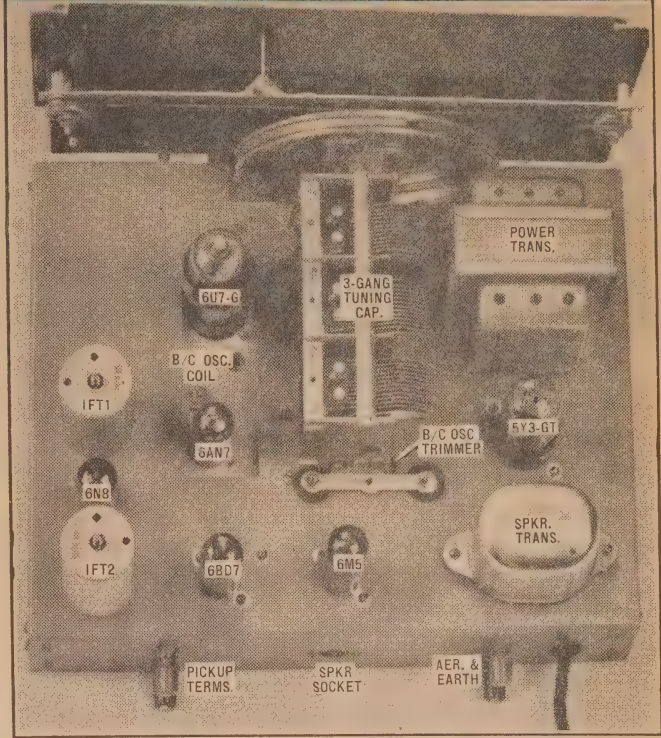
A 60-milliamp choke is not likely
to be distressed by 4 or 5 milliamps
overload and we did not bother to
change the original. If you can buy
a 70 or 80-milliamp type that will fit
underneath the chassis, so much the
better; otherwise a 60-milliamp type
should do.

So much for the circuit.

As we mentioned earlier, it is pos-
sible to instal the new tuning unit
on the chassis intended for the "Four-
Band Receiver."

The modifications consist of an ex-
tended slot for the dial drum, al-

REAR VIEW OF THE RECEIVER



Top view showing the placement of major components. The sockets for the 6U7-G RF amplifier and the 6AN7 converter are part of the unit and the valves project through a cutout in the chassis. Note also the method used for mounting the gang bracket.

tered placing of the mounting holes
for the tuning gang and a rectangular
cutout to allow the valves in the
coil unit to protrude through the
chassis. The potentiometers need
to be lowered slightly and one of
them provided with a slot to facili-
tate replacement, should this ever
prove necessary.

CUTOUT DETAILS

The cutout for the valves mea-
sures 4 1-8 x 1 1/2 in. Looking at the
chassis from the front, it is made
parallel to the right-hand side, 3in
from it, and 3in from the back.

Having made the cutout, check the
position the tuning unit will occupy
in the chassis. The hole for the
spindle will need to be elongated
and the front edge of the unit lined
up with the dial cutout, 7-8in be-
hind the front of the chassis.

Mark and drill the mounting holes,
also the access holes for a trimmer
and core which should be adjustable
from above the chassis.

Next step is to check the position
of the gang, which has to clear the
aforesaid holes, as well as the power
transformer when in the open posi-
tion. As mentioned earlier, the dial
cutout may need to be extended
slightly to clear the drum.

Holes will also need to be pro-
vided for the gang connections and
for the larger type power trans-
former.

All these changes will be made
as a matter of course in the blue-
print covering the "1955 Bandsread



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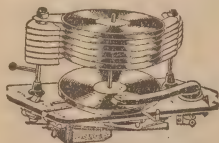
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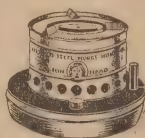
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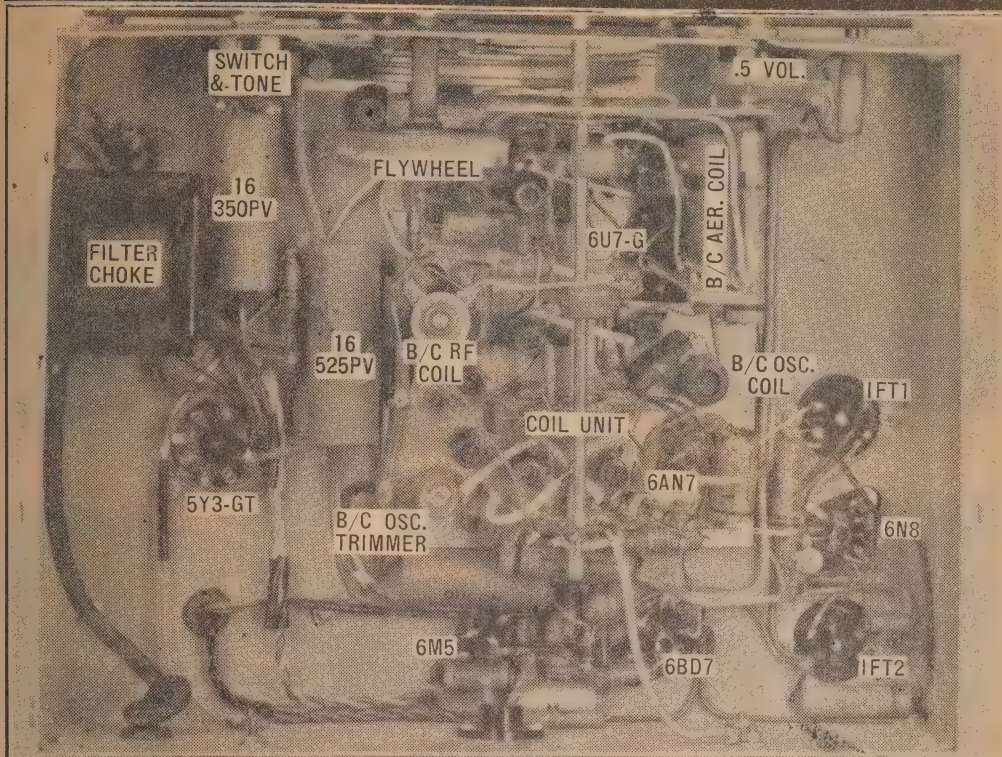
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UNDERNEATH VIEW OF THE COMPLETED RECEIVER



Most components can be identified in this picture and it should not be difficult to duplicate the original layout. As visible in the photograph, the coil unit takes up the most room with the rest of the circuit neatly grouped around it. Of particular interest is the flywheel on the tuning shaft, which fits snugly behind the bracket on the coil unit.

Six" chassis, and everything should fall properly into position.

The coil unit manufacturers have recommended that the gang be mounted on to the chassis by means of regular gang-mounting rubber grommets, which prevent the gang being stressed and also insulate the frame from more or less random connection with the chassis.

The gang wipers should then be earthed by copper braiding soldered directly to the chassis or to lugs bolted securely to it.

GANG MOUNTING

Also in line with their recommendations, the gang mounting screws should not scrape against the frame of the tuning unit. To avoid this possibility, insert the gang-mounting grommets with the smaller section below the chassis and pass counter-sunk screws with flat washers up through the chassis and gang brackets, placing the nuts on top.

After checking that everything fits, mount the gang brackets on the chassis as a first operation. Then install the tuning unit and finally attach the gang to its brackets.

It may be wise at this stage to install the dial, if only temporarily, to avoid any risk of having to "wreck" things at a later date. It needs to be the Efco USL51 type and

has first to be fitted with the glass which comes with the coil kit.

The drive spindle will need to be packed back from the plate by about an eighth of an inch and the cord slackened off a good deal. Then, using as many hands as you can muster, detach the drum from the front plate, slip the dial into position at the front of the chassis and slip the drum on to the gang spindle.

You will have to remove the flywheel temporarily to do this.

Bolt the dial in position and see that the cord has moderate tension with the springs partially but not fully extended. Lock the drum and shaft in its proper position and check the dial's operation.

If not used to handling dials, it isn't a bad scheme to sketch the threading arrangement beforehand so that you can restore order if the thing slips out of your hand.

The flywheel actually mounts behind the front face of the tuning unit, as will be seen from the photograph. It may need to be cleaned up a little with a file to prevent rough edges from fouling the wiring and components.

The thickness of the dial face plate makes it essential to use long-shaft potentiometers, which are fortunately available as a stock item. The tuning unit shaft may itself need to be extended if the front of the pro-

posed cabinet is more than $\frac{1}{4}$ in thick.

Having got everything working as it should, it would be just as well to remove the dial until the rest of the wiring and assembly is finished.

The remainder of the assembly is actually quite simple. As always, the orientation of the sockets and IF transformers is important, to ensure short leads and a minimum risk of oscillation.

SOCKET ORIENTATION

The lay of a socket is identified by the position of the gap between pins 1 and 9. For the 6N8, this is toward the 6BD7 position, for the 6BD7, it is toward the speaker socket and for the 6M5, it is toward the 6N8.

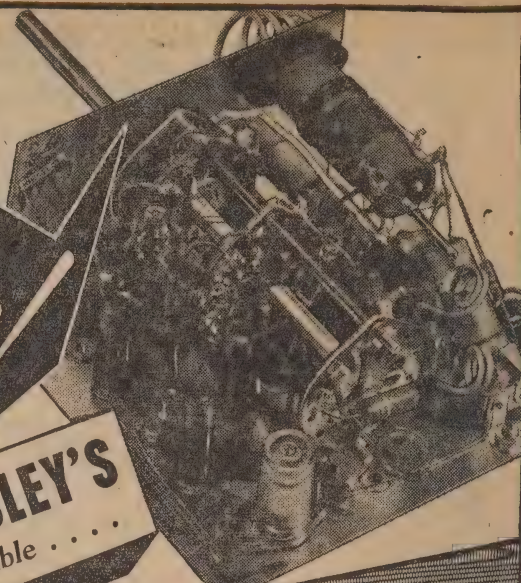
With the No. 1 intermediate frequency transformer (IFT1), the "G" pin should be the one closest to the 6N8 socket and with IFT2, the "G" pin should be toward the 6BD7 socket.

The lay of the rectifier is not very important but, as a matter of interest, we have positioned it so that the valve spigot keyway is toward the speaker socket.

In detail, the wiring is very similar to that suggested for the 5-valve set. The heater, plate, grid and other connecting leads can be laid in first followed by the smaller wiring components.

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With the aid of a small tag strip, the components for the AVC line and second detector are mounted around the socket for the 6N8.

A 4-terminal tag strip between the sockets for the 6BD7 and the 6M5 is used to support most of the components for this part of the circuit. As pin 9 on the latter socket is not required by the valve, it provides a convenient point of support for the junction of the .05 meg resistor, the .05 mfd coupling capacitor and the shielded lead to the tone control.

SHIELDED LEADS

Shielded leads are also used to convey the low level audio signal from the detector to the change-over switch and through the .5 meg volume control to the grid of the 6BD7 audio amplifier.

The volume control should be mounted in a slot cut into the chassis, as shown on the photo, otherwise it may be rather awkward to remove it afterwards. A small terminal strip is used to hold the .01 mfd coupling condenser in position. It is held under the mounting bolt of the BC aerial coil.

Ample room is provided on the left-hand side of the chassis for the power supply. The mains 'flex' is taken through a rubber grommeted hole to a tag strip near the front of the set. This tag strip also carries the connections to the power transformer. The mains are connected to the transformer through the switch on the tone control potentiometer.

Another tag strip near the rectifier socket carries the back-bias resistor and the two filter capacitors.

The connecting leads from the tuning unit fall reasonably into position except for the aerial and AVC leads which will have to be lengthened. The AVC lead has to be taken right around the unit to pin "F" of the first IF transformer.

When routing these leads care should be taken to prevent any accidental abrasion from moving parts of the dial mechanism.

Since the tuning unit comes pre-aligned from the factory, the receiver should exhibit some signs of life immediately with all the valves plugged in and an aerial and the mains connected.

ALIGNMENT CHECK

Tuning over the broadcast band, a weak station should be selected and the IF transformers adjusted for maximum volume. Next the dial should be checked to see if the stations come in where they are marked. If they are all spaced from their markings by the same distance the drive drum will have to be loosened on the shaft and the pointer adjusted until one of the stations (preferably one near the centre of the dial, say 2KY) lines up with the marking.

Check around the low frequency end (2FC) and, if necessary, adjust the oscillator coil until this station also lines up with its marking. The same procedure should be adopted for the high frequency end, these two adjustments are interdependent it will be necessary to repeat the operation before satisfactory alignment can be reached. However, it will be found that little or no adjustment is required if the

(Continued on Page 83)

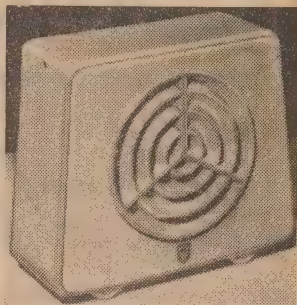
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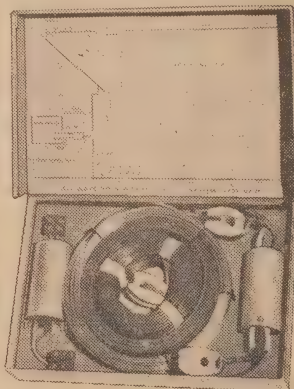
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Intermittents can present themselves in so many different forms that I am beginning to wonder what I'll strike next. This month I have a story about an intermittent noise and a set which refused to work properly for the first half hour after being switched on. There is also a story about burning dust out of tuning gangs.

MY first case concerns the noise, and I think it may fairly be termed an intermittent, since it would vary from completely quiet to a very noisy noise—or even stop the set altogether!

The owner's story was that the set had developed a faint crackling noise and that this had been going on for some time. He hadn't worried particularly about it, since it was hardly noticeable except between items, and he had simply put it down to interference of some kind. At least, that is how he had felt until the set's most recent performance.

COMPLETE FAILURE

On this occasion the noise had gradually increased in strength until it was nearly drowning the program then, with a sudden, violent splutter, the set had failed completely. He had switched it off and tried again a few hours later, being somewhat surprised to find that it was functioning again, though still giving forth a faint crackle. At this point he brought the set along to me.

The set was a moderately elaborate radiogram employing a push-pull audio system and a standard superhet tuner. This latter section employed a 6A8 converter and a 6U7 IF amplifier, while the output was a pair of 6V6's.

Set up on the bench it functioned quite well except for the faint crackling which the owner had mentioned. As far as I was concerned, I would have much preferred that it be completely dead. At least, I would have been able to come to grips with it.

THE HARD WAY

But since it stubbornly refused to die, I could only set about systematically isolating the offending stage and then the faulty component. To make things really hard, the noise would completely vanish for long periods, several hours sometimes, and then start up again for no apparent reason.

My first step was to short the aerial terminal to the chassis and advance the gain to maximum. This killed most of the signal pickup but increased the noise level considerably, thereby making it somewhat easier to work on. I quickly established that the noise varied with the volume control setting, thus showing that the audio section was not involved, and I turned my attention to the front end.

Shorting the IF grid to chassis killed the noise, but similar treatment on the grid of the converter had no effect. This seemingly narrowed the area to that involving the converter, with its associated circuitry (excluding the control and grid circuit) and the first IF transformer.

I should mention at this point that it is very easy to be deceived when tracking down noises of this kind and that the simple "shorting out" test can sometimes be misleading. This is particularly so when a noise originates in the power supply, usually in the form of a high resistance joint in anything from the filter choke to the filament circuit.

Such noises can easily appear in the first grid stage and will disappear when this grid is shifted, giving the impression that the grid circuit components are at fault.

Actually, the noise is probably appearing on all grids, but the first one, representing the point of maximum sensitivity, will respond most obviously to the shorting test. Careful observation will sometimes, in favorable circumstances, show the noise to be still present at a very much lower level, even with the first grid inoperative.

However, all that is rather by the way. Returning to my own problem, I first considered the 6A8. This was easily checked by substituting a known good one, which made no change in the crackle whatever. (I might have known it wasn't going to be as easy as that.)

Next suspect was the IF transformer. This could have a high resistance in either the primary or

secondary winding, probably due to electrolysis, and which could be a prelude to complete failure. I checked the secondary by removing the 6A8 from its socket, thus leaving only the secondary in circuit. When the crackles ceased, I reasoned that the fault was not in that section.

For the primary winding I had a different approach. The idea may appear rather rough and ready, but it is really quite effective. It is simply to momentarily short the plate pin to chassis, thus passing a heavy surge of current through the winding. It will usually find any weak spots if they exist.

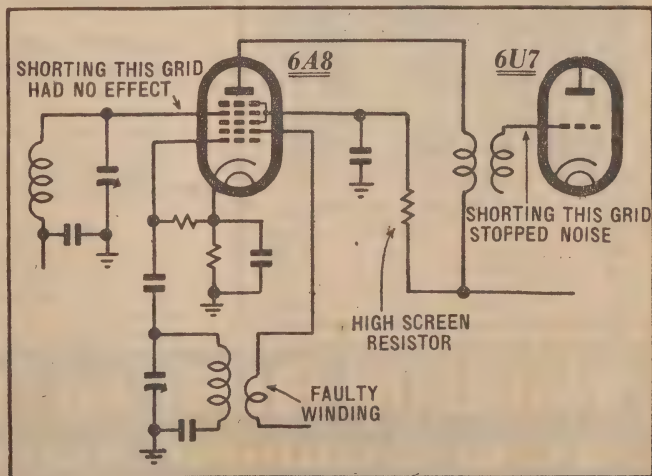
NOT DRASTIC

Although it sounds drastic, it isn't really, because any good winding will easily stand such treatment, while a weak one is best revealed as soon as possible.

But it didn't help much in this case. The winding appeared sound enough to take any amount of such punishment and I realised that the fault was not going to yield to any, such simple trick. I was going to have to search for this one!

Next I connected a voltmeter to the plate of the 6A8 and observed it carefully as the speaker gave forth its crackles.

At first it seemed to contradict the rough and ready short circuit tests, since the needle was flickering quite perceptibly in step with the crackling.



The main fault in this set was a high resistance in the plate winding of the oscillator coil, but the faulty screen dropping resistor provided a "red herring" which side tracked me for a while. The fluctuating oscillator plate voltage was also reflected on other valve elements.

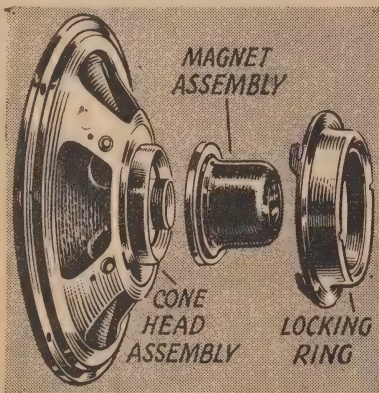
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PAGE —Check it each month

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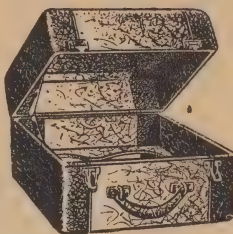
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However, more careful examination revealed an interesting point. The needle appeared to be wavering in an upward direction rather than a downward one; contrary to what one would expect if a fault in the plate circuit was causing increased resistance.

How could I be sure of this upward indication? It wasn't very hard really. During brief periods of quiet the needle would settle to a particular reading, then kick upward enough to notice as the crackling increased. The loudest crackles always produced the highest readings, though none of the variations would have amounted to more than a few volts, being only small waverings on the 250-volt scale.

SCREEN TROUBLE?

Now what kind of a fault could cause the plate voltage to rise? In general terms the most likely explanation would be anything which reduced the plate current, even though the resistance in the plate circuit was small. This idea immediately suggested the screen and its associated components, because a partial failure of the screen voltage could have just this effect.

Feeling quite proud of my reasoning I immediately transferred the voltmeter to the screen pin of the 6A8. The first point that struck me was that the screen voltage was somewhat on the low side and then, as I checked the voltage against the crackles, I found what I had expected, a downward flickering of the screen voltage as the crackling increased.

From here it was only a step to measuring the resistance of the screen dropping resistor, and this turned out to be nearly twice its nominal value. Now, of course, the whole picture was clear. The screen dropping resistor was on the way out, had doubled its value, and was noisy into the bargain. Obviously all I needed to do was fit a new resistor and all would be well.

SHATTERED THEORY

Which was just where I was wrong. Certainly a new resistor restored the screen voltage to a more normal value, but the noise was there exactly as before and my beautiful theory, which I had so carefully built up, was completely shattered.

So I was back where I started from—or almost so. I checked the screen voltage again and found that it was still wavering, downward, exactly as before. Yet there didn't seem too much left that could cause such an effect. The screen was fed through a simple series dropping resistor, the valve had been absolved, and the only other component in the screen circuit was the .1 mfd paper bypass.

I realised that this could cause such symptoms if it happened to be leaky, since it would produce a varying bleed in the screen circuit and thus produce a fluctuating screen voltage.

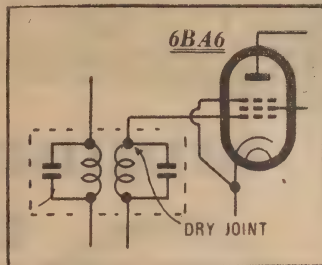
But I was wrong again. A new bypass made no improvement and a check of the old one for leakage revealed nothing. Yet the screen voltage continued to waver in the most tantalising fashion.

By now I was really puzzled. I was faced with what appeared to be the ridiculous situation where the screen voltage continued to fluctuate, yet every part of the screen cir-

cuit had been checked and found completely above suspicion.

Since I was quite satisfied about this latter fact I was forced to the conclusion that the fluctuating screen voltage could only be a secondary effect. The faulty circuit had still to be found.

Next to come under suspicion was the oscillator plate circuit. Here the voltmeter showed a similar effect to that on the screen, a downward flickering of the voltage as the set



A dry joint between the IF grid pin and the fixed capacitor was very temperature sensitive, making the set inoperative until it was thoroughly warmed up.

crackled. However, the effect was much more pronounced, the meter needle kicking across the scale quite violently during loud bursts and I was quite sure that this was the real thing.

The most likely cause seemed to be the oscillator coil plate winding and I was about to short the oscillator plate to chassis, to prove it one way or the other, when the coil itself saved me the trouble by going completely open circuit.

Gratified and all that I was to have cleared the trouble at last, I couldn't help wondering what kind of a gremlin it was that had held off the complete failure of the coil just long enough to make me go through the whole ritual of checking the circuit stage by stage, then allowing it to fail just as I finished tracking it down the hard way.

How much easier it would all have been if the coil had failed the first time I had switched the set on.

THE EXPLANATION

From a purely technical viewpoint, however, the main interest concerns the reason why a fluctuating oscillator plate voltage presented itself in the manner that it did on the other elements of the converter.

I don't know whether the explanation I am about to offer will stand the careful scrutiny of the engineers from the various valve companies (assuming, first, that they read *Radio and Hobbies* and, second, that they get as far as the Serviceman page), but at least I think it is correct in principle, even if I have not been able to fill in all the details.

Fairly obviously, the increased resistance in the oscillator coil would reduce the voltage and activity on the oscillator plate, resulting in much reduced oscillator activity, even if it did not cause it to drop out altogether. This, in turn, would bring about a reduction in the oscillator grid bias normally generated by grid current flowing through the .05 meg. grid resistor.

Thus a greater number of electrons could pass through the oscillator grid and would be available for collection by the various positively charged elements. The first of these is the oscillator plate, physically a very small electrode in the 6A8.

The next element is the screen, which is actually in two sections, one between the oscillator plate and the control grid, and the other between the control grid and the plate proper. From this it would seem that the screen would be the logical element to collect the extra electrons made available by the reduced oscillator grid voltage. In other words, the screen current would increase.

Since the screen was fed through a dropping resistor the natural result would be a drop in screen voltage, accompanied by a drop in plate current. This produced the effect which I had first noticed, namely, the rise in plate voltage as the set crackled.

At least, that's the way it seemed to work out, and I'll leave it at that.

NUMBER TWO

Another intermittent I encountered this month was of a rather different nature, in that it involved gross change in sensitivity. It also differed in one other respect from the usual intermittent in that its behavior was completely predictable.

The owner complained that when the set was first switched on it would be very weak, with barely enough gain to receive the stronger local stations at usable strength. After running for about half an hour it would suddenly come good, with normal sensitivity and general performance.

It would continue this way as long as it was running but, once switched off and allowed to cool, the whole warming up process of about half an hour would have to be gone through again.

The chassis was a normal five-valve console style of fairly modern design and using miniature valves throughout. It was the type of thing which is sold ready made for the enthusiast who wants to fit it to his own cabinet.

On the bench it behaved exactly as the owner had described. When first switched on, it was woefully weak, and I let it run in this condition until it decided to come good. Sure enough, after about half an hour, the volume suddenly jumped and a quick check around the band showed plenty of sensitivity.

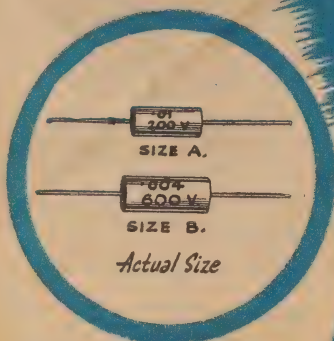
SENSITIVITY CHECK

Since it seemed that I could repeat the set's poor performance any time I liked to let it cool down, I decided to simply check the sensitivity of each stage while it was performing correctly, and then check these again when it failed. Accordingly, I hooked up the generator and went over the IF channel, noting the sensitivity for future reference, and followed this with a check from the aerial terminal. Then I switched it off and let it cool down.

Coming back to it an hour or so later I switched it on and was happy to find that it had failed again. Reaching for the generator leads I prepared to check the sensitivity at the grid of the IF amplifier valve, clipping the generator lead to the

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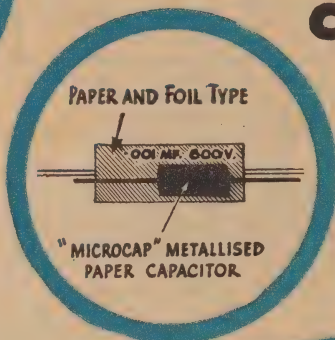


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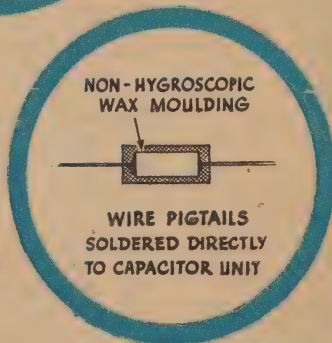
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grid pin of the first IF transformer as the most convenient point.

As I did so, the gain suddenly jumped to normal and remained so even after I removed the lead. This shattered my complacency somewhat, since it suggested that the fault could be a very touchy one; in spite of its consistent performance so far. Any fault which can be cured by simply applying a strong signal to the set deserves considerable respect.

MECHANICAL EFFECT?

This was assuming that the strong signal did actually effect the cure. I was not overlooking the possibility that the effect was a purely mechanical one, the fault being in some way associated with the IF pin I had been working on. To check this possibility I applied pressure to the pin with an insulated aligning tool and I was quite relieved when I found that pressure in a certain direction could bring on the fault.

From here it was only a step to checking the "innards" of the offending transformer and when the can was removed the fault was immediately obvious. There was a beautiful dry joint between the coil lug and the fixed mica condenser used to resonate the winding.

Obviously the winding had been hopelessly off resonance whenever the dry joint elected to go open circuit and this, due to purely chance conditions, was whenever the chassis was cold. Apparently the break was of such an order that it was not until the chassis was heated to normal running temperature that it was closed. Presumably a lower ambient temperature, as in the winter, could have caused complete failure by preventing the chassis from reaching the required temperature.

Anyway, the cure was simple—just a hot iron, a discreet amount of flux and a little extra solder, after which I re-assembled the IF and checked the set again. All was well and it needed only a touch up of the alignment adjustments to complete the job.

READER'S CASE

To round things off here is a case sent to me by a reader, Mr. R.F.C., of Dargaville, N.Z. It concerns a six-valve AC set employing an RF stage. The main complaint was poor sensitivity, even the local stations being poorly received.

After checking the RF coil and other obvious components, without success, he finally tracked the trouble to the RF section of the tuning gang which showed a leakage resistance of only 2000 ohms. This turned out to be due to a considerable amount of dust between the plates, which had absorbed sufficient moisture almost to short circuit them.

Mr. R.F.C. continues:

"To remove the dust I used a dodge that I have not seen described elsewhere. It is a bit rough, but effective.

"The lead from the fixed plates of the gang is connected to B plus and the set switched on. As a precaution, the moving plates are set right out. On starting to move them there will be a fizzing sound punctuated by an occasional loud report as something arcs over.

"A better scheme would be to insert a resistance in series with the B plus line to limit the current in case of a dead short."

Well, Mr. R.F.C., you're probably right about not seeing this idea pub-

lished before, which is one reason why I am sorry now, but I think it's safe to say that most old hands will recognise the stunt as a well-tried and proven one. Nevertheless, there should be plenty of new chums who have never heard of it before.

And speaking of new chums brings me to another reason for mentioning the subject; it gives me an excuse to reminisce about an incident in my younger days involving a new chum and the above-mentioned trick.

It was, in fact, during the early war years when I was working on defence equipment in a radio factory. In those days many components were below standard quality, often using substitute materials. Gangs in particular were a source of bother, the plates being made from plated zinc and other metals rather than the much more reliable aluminium.

The plating gave a lot of trouble, being very prone to peeling, an effect which created multiple short circuits across the gang and rendered the set virtually useless. Thus, it became quite the regular thing to have to "burn out" such gangs to get sets back into service or, indeed, to make them fit to use even when new.

MUCH TO LEARN

At this point enter our hero, the new chum, who was a not very bright specimen. He had a lot to learn but failed to appreciate the fact. Someone instructed him to burn out some gangs, explaining that they should be connected to the HT through a protective resistor, &c. He was assured by the new chum that he knew all about it.

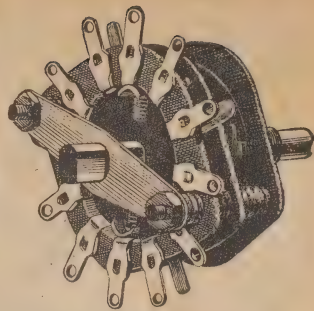
In actual fact, he had only the vaguest idea of what it was all about and his attempt to carry out the instructions were really choice. Not only did he apparently scorn such sissy things as protective resistors but he also scorned the set's HT system, connecting the fixed plates to the active side of the mains! (How he avoided electrocuting himself I will never know).

Having thus set things up so nicely he proceeded to close the gang. At first only a few fine whiskers of plating were involved and these disappeared nicely on a series of blue flashes. Then something more drastic happened. Either there was a particularly large piece of plating or the gang had a bent plate which, shorted out. Anyway, whatever the cause, there was a blinding blue flash, a cry of fear from our hero, and the snap of a main circuit breaker going out.

After the hubbub bubble had died down someone in authority found out what had happened, unplugged the receiver from the mains and pushed in the circuit breaker, thus restoring power to the rest of the factory. Then we surveyed the damage. Apart from our hero's nervous system, the main casualty appeared to be the gang itself which was virtually a "write off", the two plates which had caused the short being well and truly welded together.

Naturally, there were some very caustic comments directed at our hero, for gangs were a scarce commodity in those days and the loss of a gang meant the loss of a set, at least until many miles of red tape had been handled in order to secure a replacement.

That was another lesson learnt—the hard way.



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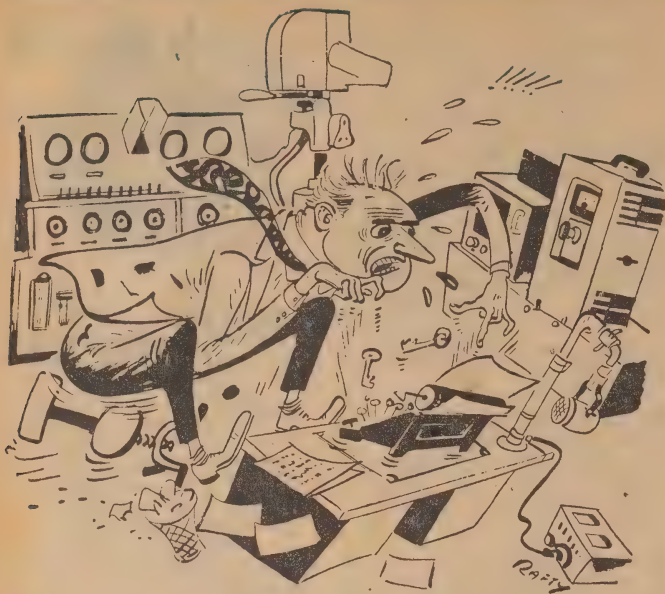
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for "plate voltage" figures of 500 or more volts. Battery valves may require little more than 200 volts on this scale.

Power output valves will normally require a more liberal "plate current" scale than other types, because they're designed to draw higher current.

For the most part, triode curves have the general appearance of figure 1. Pentode and tetrode curves are of a different shape and have the general appearance of figure 2. The zero grid bias line is toward the top, with curves representing progressively higher values of negative bias below it and to the right.

SCREEN VOLTAGE

Pentode and tetrode curves are always drawn for stated values of screen voltage, since this has an important bearing on the behavior of the valve.

It is quite a simple matter to read off from the curves the information they primarily set out to give. Assuming any likely value of plate voltage and grid bias, the resultant plate current can be read off.

Alternatively, the bias can be read off which will ensure a certain order of plate current with a certain plate voltage applied. Intermediate values of bias, not actually shown on the graph, can be deduced by interpola-

Let's Buy An Argument

I doubt whether the subject I have chosen this month rightly belongs to the "Argument" columns at all. It is sufficient to say, however, that it stems from a letter addressed to us by a NSW reader, whose problem may well be your problem also.

I SUGGEST, at this juncture, that you read his letter on the opposite page.

Checking through it, I must congratulate the writer on his powers of expression and on his excellent summary of resistive load-lines.

It's rather strange that, having digested so much, he has missed the vital point in relation to inductive load lines. Hence the letter.

Perhaps our reply would be more helpful to all concerned if we were to start right back at the beginning and explain what a load-line is.

IN LIGHTER VEIN

It rather reminds me of a remark attributed to a character in one of the many daily "comic" strips. Having obviously failed in his efforts to instruct a would-be woman driver, the said character is depicted as saying, "Madam, let's start all over again. This is what we call a car

for enthusiasts to regard curves as "terrifically technical" when, in fact, they generally contain a lot of information in quite simple form.

The "plate family" is probably the best known of all valve curves and takes the general form of figure 1.

Plate voltage is depicted along the horizontal axis, plate current along the vertical axis.

The curved lines are for varying values of control grid bias beginning, as a rule, with the zero bias curve on the left and a series of curves to the right, each one for a progressively higher negative bias.

Actual details of the graph naturally vary with the valve type. Mains-operated valves, for example, may have their characteristics drawn

ting between the lines actually drawn in.

If you want a little practice at reading curves, we show in figure 3 the plate family for a 6C5.

What, for example, would be the plate current with 200 volts applied to this valve and a bias of minus 6?

Answer (from the curves): 7 milliamperes.

Say the bias were increased to minus 7 volts, what then? Well, if you imagine that the "minus 7" curve would lie midway between minus 6 and minus 8 volts, it would cut the 200-volt plate line at about 5.2 milliamperes.

So you can go on, reading off values, ad lib.

One must note, however, that the previous paragraphs contained more than just plate current readings.

They contained the interesting information that a change of 1-volt in the bias produced a change of 1.8 milliamperes in plate current. In other words, the transconductance of the valve in that region is 1.8 milliamperes per volt or 1800 micromhos — if you prefer it that way.

by **Neville Williams**

As starting point, then, most of us have seen a "plate family" of valve curves. Whether we've paused to examine them, is another matter. There is an unfortunate tendency

VALVE CURVES AND LOAD-LINES

It would be more accurate to read off the plate current change for say 2 volts, dividing the answer by 2. By such means, you can proceed to a whole series of fun-games—working out transconductance from the plate family. You will find that the figure varies a good deal, according to the region of the curve from which you take it.

This is consistent with the fact that transconductance does vary somewhat with plate current, being higher when the plate current is higher and vice versa.

And it needn't stop there. The spacing between the grid bias lines, related to the plate voltage scale is a direct measure of the valve's amplification factor.

Say we trace along the 8-milliamp line. It cuts the zero grid bias line at a point equal to a plate voltage of 90. Now follow it along to where it cuts the minus 12 bias line at a point which is equivalent to a plate voltage of 328.

In so doing, we discover that a change of 12 volts in the grid bias is able to offset a change of 238 volts in the plate (328-90), the plate current remaining unchanged at the suggested figure (for this valve) of 8 milliamps.

Thus, the effective amplification factor works out at $238/12$, which is very close to the published figure of 20.

PLATE RESISTANCE

If still not satisfied, you can ascertain also the effective plate resistance of the valve at any point on the graph, by examining the slope of the appropriate bias line.

For example, you might draw a straight line, which is asymptotic to the "minus 8" bias line at 8 milliamps of plate current. In other words, your straight line should have the same apparent slope as the bias line at the particular reference point.

By carrying the line to the limits of the graph, as shown, you will find that it traverses about 160 volts horizontally and 16 milliamps vertically, giving a slope equivalent (by Ohm's law) to 10,000 ohms.

So you see, without going beyond quite simple graphical operations, we have managed to extract a whole lot of useful data about the valve in question. If's all there, in the plate family. Pentode curves are more difficult

I have been studying load lines and have been having some trouble reconciling one piece of information the graph gives with what I know of operation characteristics. I thought you might be able to resolve my difficulties.

I have no trouble understanding all aspects of a load line drawn for a valve loaded with a resistance.

The anode voltage fluctuates (with a large drive from the grid) from the full value of the supply voltage at zero anode current, down to a considerably lower value at maximum anode current. The mean anode voltage lies midway between the two, and coincides on the graph with the mean grid potential, and the mean anode current. The slope of the load line is a measure of the value of the load resistance.

The grid drive along the load line in practice does not travel the full distance of the load line, but only as far as zero grid volts in one direction to twice the bias in the opposite (Class A). The slope of the load line is chosen to give as near as possible equal intercepts with the various grid voltage lines to minimise distortion.

Under these conditions, the anode voltage at no time exceeds the supply voltage. I know that if the load were inductive, the load line would be elliptical and the peaks of anode voltage would exceed the supply voltage, which would be re-inforced by the back EMF of the inductive load.

My difficulty comes when I look at some published load lines

for power valves; that is where the anode voltage is practically equal to the supply voltage. For instance, take the graph and load line of the 6V6.

Here, the operating conditions of the diagram coincide with their "typical operating conditions" Class A. The operating point gives a grid bias of 12.5 and a mean anode potential of 250V. The load line cuts this point at a slope of 5000 ohms.

Now, if I read this graph, I find that when the grid is driven negative say 20V, the plate current falls to about 20 mA and the plate voltage rises to about 380V, which is 130V in excess of the supply. I can't get this.

If I draw in a fresh load line parallel to the first, but cutting the plate volts line at 250V, to correct this anomaly (anomaly to me, that is) we get into a region where there would be severe distortion due to unequal intercepts between the grid lines.

To avoid complications, let's assume that the load is not a loud-speaker, which gives reactive plus resistive loading at some frequencies, but a straight out resistance, coupled to the plate circuit by a 1:1 transformer. (See figure 6.)

Now, so far as I can see those extra volts on the plate at a high negative grid potential, can't be there, but the graph tells me they are. Possibly these graphs have limitations when it comes to making them show a number of conditions correctly, simultaneously. — (F. M., Neutral Bay, NSW.)

to analyse, because of their peculiar shape, but the same basic approach holds good. As you soon learn, the nearly-horizontal lay of the curves reflects itself in an enormous amplification factor and a very high figure of plate resistance — characteristics for which the pentode is famous or infamous, depending on how you want to use it.

However, all this talk of amplification factor, transconductance and plate resistance is beside the point—interpolated only to illustrate what

you can extract from a set of curves. It has very little bearing on what we started out to discuss, namely load-lines.

We have neither the space nor the inclination at this stage, to get entangled with all the complications of the subject which can arise. Let's have a look at two straightforward cases and, in so doing, answer the question which our reader posed for us at the outset.

Figure 4 shows a second family of curves extracted, for purposes of

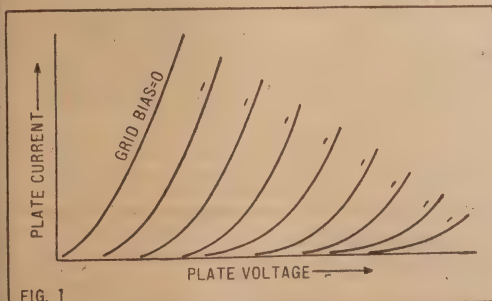


FIG. 1

Figure 1: A "plate family" of curves for a triode follows this general pattern, the upward slope of the lines indicating moderate values of plate resistance and amplification factor.

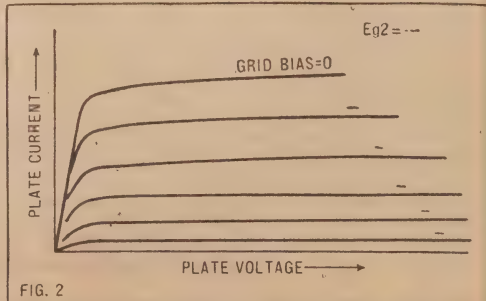


FIG. 2

Figure 2: The plate family for a pentode or tetrode looks more like this, the curves rolling over to the near-horizontal. Over most of the range, the plate resistance is obviously very high.

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illustration, from an old valve data book. They happen to be the curves for a 6C8-G.

We have drawn a couple of lines across them for reasons which we'll explain in a moment. Just ignore them for the time being.

If you like studying curves, you can note the differences between them and those in figure 3, for the 6J5. The differences are, of course, those between the valves themselves.

TYPICAL OPERATION

Published data for the 6C8 suggests "Typical Operating Conditions" as follows: Plate voltage 250; Grid bias minus 4.5; Plate current 3.2 milliamperes. We have ringed this point on the curve for all to see.

Now this information is nice to have in the rather unlikely instance of the valve being used in a transformer-coupled circuit. There won't be much drop across the transformer primary and the effective plate voltage will be very close to the supply. It is quite easy to use the published conditions.

But resistance-coupling is a very different proposition because the plate resistor reduces the effective voltage to some rather indeterminate figure, thereby affecting both plate current and optimum grid bias. But by how much? This is where our load-line comes in.

By drawing a load-line on the plate family of curves, one can predict the whole performance of a resistance-coupled stage, including optimum bias, plate current, bias resistor, gain, peak output, and distortion.

Let's perform at least part of the operation on the 6C8 curves.

SUPPLY VOLTAGE

One must begin by assuming a supply voltage for the stage, which may be that of the main HT line, or a somewhat lower figure, due to the presence of decoupling. Let's say it's 300 volts.

The design might well call for an average kind of plate load resistor—not too high and not too low in value. We shall settle for 0.1 meg.

By Ohm's Law, the maximum current which can flow through a 0.1 meg. resistor from a 300-volt source is 3 milliamperes. So we draw on our curves of figure 4 a "load-line" stretching from the 300-volt point to the 3-milliamp point. No sooner said than done.

Our operating point for the stage will now lie somewhere along this line.

If the valve is to be used in a position where it has to supply a high signal output voltage, then the operating point is best located about midway between the zero-bias line and one which intercepts the load-line fairly close to plate-current cut-off.

This would suggest about minus 4 volts.

Examining this point indicates, as we have said, a grid bias of minus 4, an effective plate voltage of 180 and a plate current of 1.2 milliamperes. This allows us to calculate the cathode bias resistor as $4/.0012$ equals 3300 ohms. So far so good.

While the plate resistor sets the initial operating point, the real load

TYPICAL TRIODE VALVE CURVES

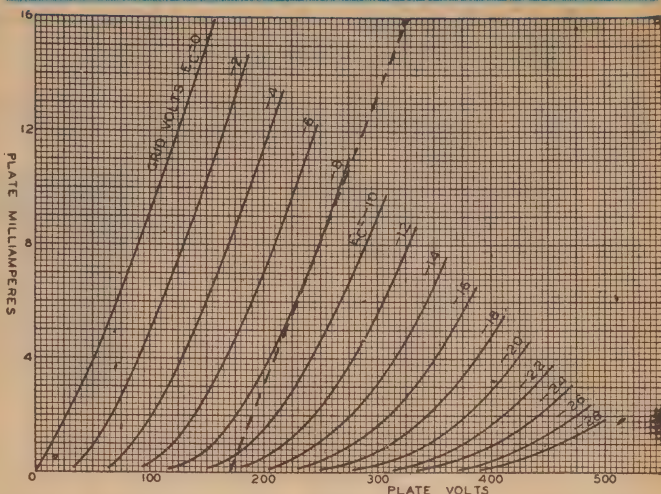


Figure 3: A typical set of curves, actually those for the 6C5 general-purpose triode. They give complete information about plate current and also allow the amplification factor, transconductance and plate resistance to be deduced.

is provided by the sum of the plate load and the following grid resistor in parallel. If this latter is 0.5 meg., then the so-called "AC" load on the valve is 80,000 ohms.

We therefore have to draw a new load-line through our selected operating point but with a slope equivalent to 80,000 ohms. From this line it is possible to determine such important things as stage gain, peak signal output and distortion.

Thus, along this new load-line, from zero bias to minus 8, the equivalent plate swing is from 75 to 267 volts. In other words, a total excursion of 8 volts on the grid produces a swing of 182 volts at the plate, representing a stage gain of 22 times.

Since the peak-to-peak swing is 182, the nominal signal amplitude would be 91VP or 64V RMS. This figure is actually rather extravagant because, in practice, a valve should not be required to run right up to zero bias or so close to cut-off.

If you measure the two halves of the load-line, it will be found that the section from minus 4 to zero is longer than the section from minus 4 to minus 8. This discrepancy is an indication of distortion and the percentage can be calculated by the application of suitable formulas.

By arranging the design so that the valve need deliver something

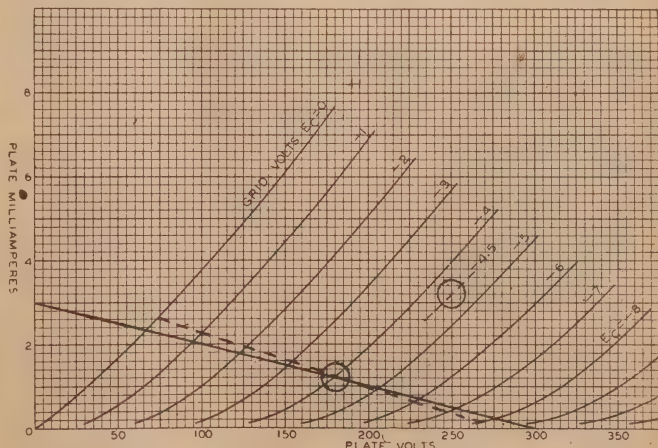


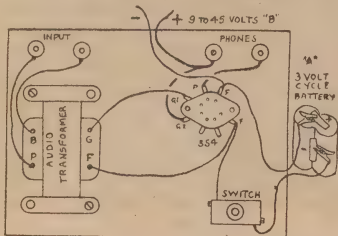
Figure 4: Another set of triode curves, actually those for the 6C8. The article describes how the load-lines are added and the information that can be derived therefrom.

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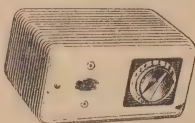
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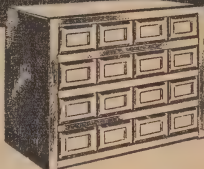
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less than its maximum output, a smaller increment of the load-line is used, there is less discrepancy between the sections and the distortion content is lower.

We can learn quite a lot about the operation of the stage!

If the following grid resistor were substantially lower than the 0.5 meg. value we have suggested, the slope of the AC load-line would naturally be steeper. This would obviously render unsuitable the operating point centred on the minus 4V bias line and minus 3V would probably be a better choice.

This would involve reducing the cathode bias resistor to 3/0015, equals 2000 ohms.

So it goes on.

TABULATED DATA

Fortunately, one doesn't always have to go through the laborious process of drawing load-lines, though it is nice to know how should the necessity arise. These days a lot of data is available in tabulated form, giving resistance coupled operating conditions for most of the popular valves.

While it is logical to use this data, it is nice to understand why, for example, the value of a following grid resistor affects the optimum bias.

When it comes to resistance-coupled pentodes, one has to rely almost completely on tabulated data, or else dig in a lot deeper than we are prepared to go here. The pentode has another important variable—the screen—and it complicates the business no end.

One fact remains true, however, of any resistance-coupled amplifier: The plate voltage may vary widely with signal but it can never exceed the supply voltage.

This is the point which our correspondent has apparently reached without any special difficulty. But he asks, what happens in the case of an output valve? Does the load-line idea break down completely or has he missed something? We shall see.

OUTPUT VALVE

Figure 5 shows a set of curves for the 6V6. You will see immediately that they follow the general pattern suggested in figure 2 for pentodes and tetrodes. But they show a few other things as well.

Don't be put off by this, because the "other things" are really very mysterious.

In the first instance the curves are drawn for grid bias voltages, positive as well as negative. This is done because the 6V6, in common with quite a few other output valves, can be used in Class AB2 operation, where the grids are deliberately driven positive.

If we are concerned, as here, with only Class A operation, the positive curves can be ignored and attention confined to the zero bias curve and those below it.

Then also, the graph contains information about screen current and grid current, once again relating to Class AB2 operation. For our present purpose, this can likewise be ignored and attention confined to the lower left-hand portion of the figure.

Now what about the operating point, assuming ordinary Class A operation?

If one wished to be very rigorous,

CURVES FOR 6V6 OUTPUT VALVE

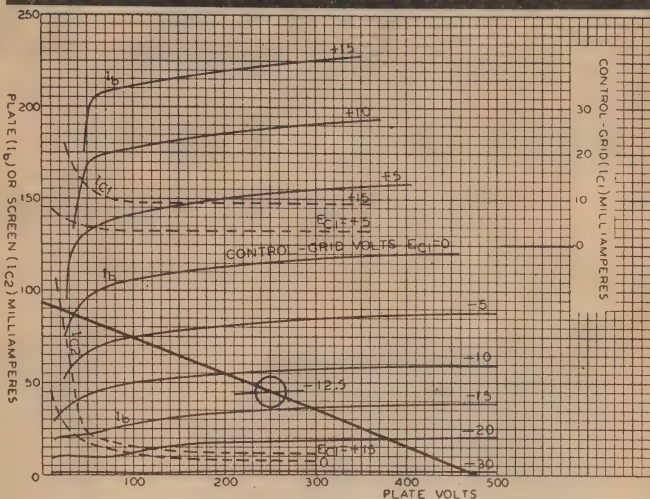


Figure 5: Curves for a 6V6, drawn for a screen voltage of 250. If the load-line is valid, asks a correspondent, whence all the extra volts that appear at the plate when the grid swings negative?

it could be "discovered" by the same technique as used for a resistance-coupled stage. Assuming a 250-volt supply, a DC load-line could be drawn with a slope equivalent to a couple of hundred ohms, or whatever the DC resistance of the output transformer primary happened to be.

The operating point would be at the intersection of this nearly-vertical line and the appropriate bias line.

Such a degree of finesse is seldom warranted, however, because the designer is seldom concerned about achieving the precise voltages for which the curves are drawn. Added to this are variations in the valves themselves and all the delightful uncertainties of a loud-speaker load.

The usual procedure is simply to ignore the DC drop across the transformer primary or to counter it

by applying a slightly greater supply voltage.

On this basis, we can mark as our working point for the 6V6, the intersection of the 250V plate line with the minus 12.5V bias line. This gives us the familiar figure of 45 milliamps plate current.

Since this is the quiescent point for the plate circuit, we must expect the load-line to pass through it.

Furthermore, if we assume that the dynamic or AC load is equivalent to a 5000-ohm resistor, the load-line must have a slope equivalent to this value. In other words, it will occupy the position shown in figure 5.

How do you get this load-line? Easily!

Simply draw a line across any convenient sector of the graph equivalent to a slope of 5000 ohms, then draw a line through the operating point, parallel to it.

For example, a line stretching from 500 volts to 100 milliamps is equivalent, by Ohm's law, to 5000 ohms. It passes just above our selected operating point, so that the load-line you see would fall just a trifle below it. Try it for yourself.

Actually, we didn't draw in two lines. Having realised that the load would fall just below the aforementioned 500-volt to 100-mA line, we "wangled" a straightedge and slide-rule till we found that a line drawn from about 475 volts to 95 milliamps would have the required slope and also pass through the operating point. And there it is.

Just to make sure you don't miss the point, let's re-state the basis on which the load-line is drawn.

(1) It assumes that the plate is supplied through a path having very low DC resistance but very high reactance to alternating (or signal) currents. The supply path—usually

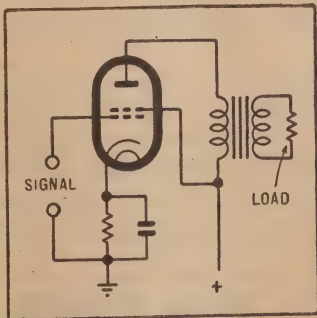


Figure 6: The basic circuit of an output stage. The plate is supplied via a transformer winding, the load being reflected back into this winding from the secondary.

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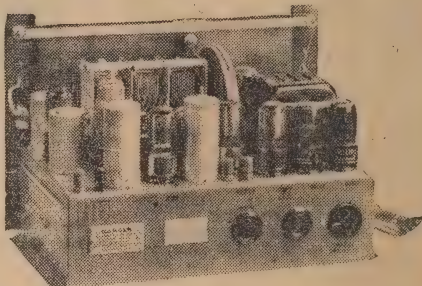
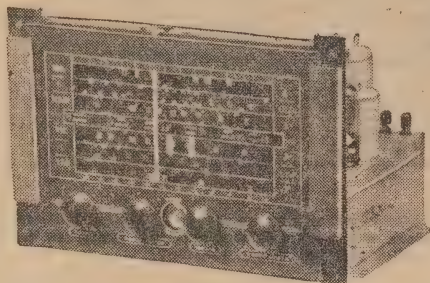
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a transformer winding—is not the load.

(2) The load is a resistor, or its equivalent, which is connected into—or reflected into—the return circuit between the plate of the output valve and its cathode. Cyclic changes in plate current develop changes in plate voltage across this load, according to a simple Ohm's Law relationship.

Now let's look at the curve again and visualise the conditions in our basic circuit. With no signal applied, the valve is drawing a steady 45 milliamps through the supply winding; the core is in a certain state of magnetisation and there is no signal voltage across the output load.

EFFECT OF SIGNAL

Now we apply a positive-going signal, reducing the bias to say 10 volts on the peak of the half-cycle. The plate current swings upward, producing a signal voltage across its load and increasing the magnetising effect on the supply transformer core. Our curve tells us that plate current actually rises to 55 milliamps, while the instantaneous plate voltage falls to 200.

But the process does not stop there. With balanced input, the grid voltage swings back to 12.5 and then beyond in to the converse peak at minus 15 volts. The magnetic field in the supply transformer collapses in cyclic fashion, generating an emf which adds to the supply voltage.

The magnitude of the back emf is itself limited by the presence of the load and our graph tells us that the plate voltage rises to 296 volts while the current falls to 36 milliamps.

This, I think, is where our correspondent's ideas have become snarled up. He has apparently assumed that back EMF's can only be generated when the load is itself reactive. Such is not the case.

As long as we have in circuit a transformer or choke, in which magnetic fields are generated by the alternations of plate current, we must expect the generation of counter EMF's. This will be true, whether the terminal load is a resistance, as envisaged, or something more complex, like a speaker.

If a larger signal is applied to the grid, the voltage can swing from something less than 50 to a figure almost double the supply. In fact, some quite spectacular things can be made to happen.

If the load applied to a pentode or tetrode is increased substantially above optimum, very high voltages indeed can be generated.

Increasing the load in figure 5 beyond 5000 ohms would bring the load-line nearer horizontal, extending its interception with the high-value bias lines well out beyond 500 volts.

Carried to extremes, it is entirely possible to make pentode valves flash across their bases and sockets, as we quickly learned when manufacturers released their first batch of 6L6's!

I think we've answered our correspondent's question at this juncture. Loadlines are valid in the basic circuit of figure 6 and output valves do generate peak plate voltages in excess of the supply.

However, we may as well go a little further and round off the story.

The circuit of figure 6 is all very nice, but it is a long way removed from a practical output stage, where the plate is fed through the primary of a very commonplace transformer and the load is a loudspeaker.

PRACTICAL CASE

(1) The DC resistance of the primary does lower the plate voltage slightly, as we have said, and modifies the true value of the AC load.

(2) The reactance of the primary winding may become low enough at very high and very low frequencies to shunt the true load appreciably. That is one basic reason why the "frequency response" of cheap output transformers is poor.

(3) Loudspeakers are highly reactive devices and their "resistance" is very largely a nominal figure.

Because of these factors, a resistive loadline for an ordinary output stage is a gross over-simplification of circuit conditions. While using it for elemental calculations, one must always keep in mind that the loadline will generally be a load-ellipse, whose shape reflects the amount of reactance in the load circuit of any particular frequency.

And because an ellipse occupies more "room" on the graph than a straight line, a reactive load may carry the valve into the non-linear grid-current and plate cut-off regions more readily than a resistive load. Hence some of the current discussion on the merits of triodes and pentodes with reactive loads.

We are bordering here, of course, on another very big subject, and it's obviously time to call a halt. Sufficient to say that the kind of char-

acteristics exhibited by a triode are less sensitive to vagaries of load than those of a pentode or tetrode.

But why did I so carefully say, "The kind of characteristics exhibited by a triode . . . ?" I'll tell you. Right now, a whole lot of people in the audio world are discussing whether pentodes and tetrodes with feedback really have "triode-like" characteristics. Whether the Ultra-Linear circuit is "triode-like".

The Editor's in it, right up to his ears! Or should I say right up to mine? He's been bashing them hard enough.


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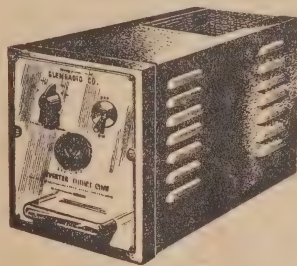


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Here's your answer, Tom!

For a change, Tom's questions come this month from New Zealand. They cover a wide variety of subjects, ranging from Localt valve bases and oscillator coils to battery filament circuits.

WE can be quite certain that the same problems have worried other readers at times.

Tom's first question is:—

What are Localt valves and how do they differ from ordinary octal-based valves? Do they have any advantages over the ordinary octal-based variety?

Well, Tom, Localt valve bases are just ordinary radio valves, like octal or any other kind, except that they are fitted with a special type of base. They were used extensively before and during the war in mobile radio equipment, where mechanical rigidity was essential.

You see, Tom, the common "gar-



"Shake it well..."

den variety" of radio valve base is only held in its socket by friction and its own weight. Turn an old-style radio upside down, shake it well and see what happens! Most likely you'll have to buy a new rectifier and power valve! But mobile and airborne radio equipment is often turned upside-down and shaken—so you can see the problem.

Then, again, all such equipment has to be kept as compact as possible. This makes it necessary to mount valves and other components at all sorts of crazy angles, sometimes upside down, to fit them into available space. As they might not have to be in their sockets on their own accord, some means have to be found to keep them there.

Various means have been used, such as rubber bands, springs and metal caps, but these sometimes put strain on the glass envelope, causing premature failure. Could there be a better way?

So, one day, some bright person came along and asked, "Why not lock

the valves into their sockets?" So the "Loc"-tal base was born.

From above, it does not seem to be very different from an octal socket. Inspection from the underside, however, reveals a spring catch, which locks the valve more securely into position.

The spigot on the valve base is extended and its end formed into a ball. When the valve is pushed into the socket, this ball clicks into the spring clip in the socket and is locked into position. Vibration or sharp jolts cannot dislodge it and it does not matter in what position the valve is mounted.

"Localt" is actually a trade name for an 8-pin lock-in base, used by a particular manufacturer, but the term is freely applied to all lock-in valves using the same principle.

Lock-in type valves enjoyed a brief period of popularity, but have since been largely superseded by the miniature range.

Of course Tom has found out long ago that valves alone won't make a radio work, so the next question he fires at us is about oscillator coils.

I notice that a New Zealand coil manufacturer specifies that one of his coil types is to be used in a plate tuned oscillator circuit. What advantages has the plate tuned oscillator circuit over the more usual grid tuned circuit and would these coils be suitable for use in a grid tuned circuit?

Well, Tom, without knowing all the circumstances, we can't very well discuss the wisdom of specifying plate tuning. We can say, however, that it would be most important to understand the connections to the coil.

DIFFERENT SIZE

Oscillator coils for both tuned-grid and tuned-plate applications have two windings. The untuned winding in each case has only about one-half to one-third as many turns as the main tuned winding. As you can see from the diagram of the tuned grid oscillator, this smaller winding is in the plate circuit, whereas, in the tuned plate oscillator, it is in the grid circuit.

Very obviously, a coil must be wired into the kind of circuit for which it is intended, otherwise we might find ourselves trying to tune the smaller winding — with rather hopeless results.

Both circuits have their advantages and disadvantages. The tuned plate oscillator has somewhat better frequency stability and is often used in designs in which such characteristic is important, such as communication

receivers. But it also has the disadvantage of being a more awkward circuit to use in practice.

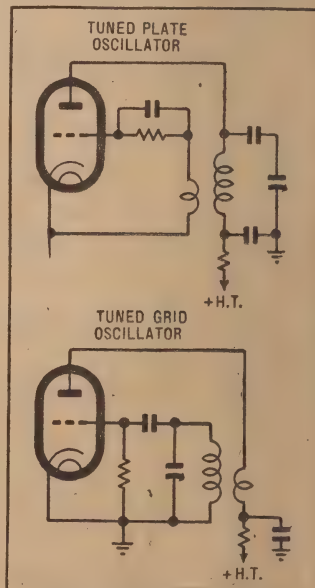
Because the coil to be tuned is in the plate circuit, one side of the tuning capacitor fundamentally has to connect to the HT supply and the other to the plate of the valve. Thus, both sides of the capacitor would be "hot", i.e., connected to a high voltage source.

This means that either the entire section of the tuning gang has to be insulated from the remaining sections, or the circuit must be modified to allow a normal gang to be used.

ISOLATING CAPACITORS

This may be done as shown in the diagram by providing isolating capacitors which are effectively between each side of the tuning capacitor and the rest of the circuit. Naturally, these will have to have an impedance many times lower than that of the tuning capacitor, if the tuning range is not to be upset.

By ordinary domestic receiver standards, frequency stability is not a serious problem and any advantages that plate tuning may have in this respect have not been sufficient to outweigh the somewhat more awk-



Illustrating the difference between a plate-tuned and a conventional grid - tuned oscillator.

ward nature of the circuit. Grid tuning has, therefore, been retained as the "standard" method and ordinary coils are coded and sold on this basis.

If you happen to have an oscillator coil which was originally designed for a plate-tuned oscillator, it would be quite an easy matter to adapt it to grid-tuned operation.

If you have a closer look at the diagram you will see that the tuned winding of the coil is always the larger one. It is thus only a matter of reversing the connections to the coil to convert it from one form of operation to another.

CHANGED CONNECTIONS

In the case of a plate-tuned coil, you would simply connect the terminals marked P and B-plus to the grid and earth, respectively, parallel to the tuning capacitor. The terminals marked G and F will now be connected to the plate of the valve and to HT. It will then be ready to operate as a grid-tuned oscillator.

Tom's next question is really several questions closely linked, so we are treating them separately. The first part is as follows:

If the HT positive voltage in a battery set is, by mistake, placed on the positive filament pin of a string of parallel connected valves would the valve filaments be burnt out? I cannot see how they would when one considers that the back bias resistor would normally limit the current to something like 200 mA, while a 5-valve set would require 300 mA to heat the filaments.

Yes, Tom, your assumption is correct, as far as it goes, but the circumstances may not always be as favorable as you suggest. While only a single faulty connection within the set was involved, or an incorrect battery connection was limited to transplanting only the high and low tension positive leads, the back bias resistor would give protection.

Unfortunately, Tom, there are many other ways of getting battery leads mixed up, as most old hands at the game will testify.

For example, if it is possible to transpose one each of the HT and LT battery leads, then it will be just as easy to transpose the complete pair of each. In fact, it will sometimes be easier, because the leads will probably be paired off in some manner.

NO PROTECTION

When this happens its just too bad and, to make matters worse, there is practically nothing that can be done to protect the valves from such a mistake.

Nothing, that is, except for the owner to exercise enough care to see that such a connection never occurs!

Another possibility, Tom, is that the valves may be connected in series. In this case there is frequently no need for a back-bias resistor, the filament voltage being used to provide bias.

Even when enough bias cannot be obtained in this way and some back-bias has to be provided, the value of the resistor is hardly likely to be high enough to protect the valves, particularly as the normal filament current would now be reduced to 50 mA.

If this (the protection afforded by the back bias resistor) is so, would not the insertion of a 500 ohm resistor between HT negative and chassis be a useful safeguard against an inexperienced and unfortunate constructor mixing up the HT and LT leads and being "five valves in the red"?

We sincerely hope, Tom, that your question is prompted by the possibility rather than the reality. If not, please accept our sympathy.

However, to get back to the question itself. Such a resistor would provide protection, but only subject to the limitations we discussed in answer to the first part of your question. That is, it would help if you confused only one lead, but not if you confused two.

LOSS OF H.T.

In addition, it would have the disadvantage of wasting several volts which should be available in the HT system. Considering that we never really have as much power for these sets as we would like, such a waste would be intolerable.

Not only would it detract from the performance of the set, even when the batteries were new, but it would also increase the running cost by making it necessary to discard the HT battery sooner than would otherwise be necessary.

What has happened to the old idea of connecting a torch or dial lamp in the common HT and LT negative lead, to act as fuse and so protect the filaments? Can I use this if my other suggestions will not work?

There appear to be several reasons why this idea has been dropped. Tom. One is that a commercially made set, fitted with proper battery plugs, is virtually foolproof, it being impossible to plug into the wrong battery. Since no one, apart from a trained serviceman, should do anything more to such a set than change the batteries, there is really no problem.

Another disadvantage of the fuse idea is that the lamp socket is just one more component to give trouble, since a lamp which works loose in the socket can render a set completely inoperative.

Again, most modern sets have an electrolytic capacitor across the HT line and this presents, momentarily, a very low impedance every time the set is switched on. This could easily burn out the fuse, even though

there was no actual fault in the set.

The position is made more difficult by the gradual reduction in filament current over the years, making necessary a very light fuse if it is to be effective. Not only is this more likely to be blown by the surge already mentioned, but it becomes necessary to select a lamp with much more care.

Fairly obviously, an ordinary dial lamp, which operates on 300 mA, is not going to afford much protection to a string of filaments which pass no greater amount of current themselves. Some torch globes operate on lower currents, 150 mA dial lamps are available, and the globes used for tail lamps in cycle generator sets operate on currents as low as 50 mA.

Summing it all up, Tom, we would say that the protective steps you can take would depend largely on the circumstances in which they are supposed to operate.

If you merely want to guard against mixing up your battery leads whenever you change batteries, the best method would be the fitting of proper plugs to the leads and the use of batteries with built-in sockets. Most batteries are made in this manner nowadays.

MAY HELP

On the other hand, if you wish to protect the filaments while you prod the "innards" of an upturned chassis with a screwdriver, the protective resistor or fuse, as a temporary connection, may be worthwhile.

However, don't let such protective devices lead you into a false sense of security. The only real protection is extreme care, both in building and servicing the set.



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TYPE 915 — 15 watts.
Prim: 5000, 3000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

TYPE 917 — 15 watts.
Prim: 10000—8000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 918 — 15 watts.
Prim: 10000, 8000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

TYPE 922 — 25 watts.
Prim: 8000 ohms P. P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 921 — 35 watts.
Prim: 6000 ohms P.P.
Sec.: 500, 250, 166, 125, 100 and 83 ohms.

TYPE 892 — 55 watts.
Prim: 3200 ohms P.P.
Sec.: 500, 250, 166, 125, 83, 62 and 50 ohms.

DRIVER TYPE

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Prim: 5000 ohms S.E. or P.P.
Sec.: 7100 ohms per side response: 200-7000 cps.

TYPE 545 — 10 watts.
Prim: 4000 ohms S.E.
Prim: to $\frac{1}{2}$ sec. rated 1000
1 response: 20-10000 cps

Modulation Type

TYPE M175 — 7.3 — 75 watts.
Response: 200-7000 cps.
Prim & Sec. Multi-impedance.
Ceramic terminals fitted with spark gap and closed steel case.

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+ - 1ab 20-15,000 cps

OUTPUT TYPE

TYPE 763 — 15 watts.
Prim: 5000, 3000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7, and 2 ohms.

TYPE 920 — 15 watts.
Prim: 5000, 3000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 896 — 15 watts.
Prim: 10000, 8000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7, and 2 ohms.

TYPE 897 — 15 watts.
Prim: 10000, 8000 ohms P.P.
Sec.: 500, 250, 166, 125, and 100 ohms.

SPECIAL HI-FIDELITY

+ - 1 ab 20-40000 cps.

OUTPUT TYPE

TYPE 870 — 6 watts.
Prim: 10000 ohms P.P.
Sec.: 2 or 8 ohms (for "Rola" 120X)

TYPE 871 — 12 watts.
Prim: 10000 ohms P.P.
Sec.: 2 or 8 ohms.

TYPE 872 — 12 watts.
Prim: 10000 ohms P.P.
Sec.: 3.7 or 15 ohms.

ULTRA-LINEAR OUTPUT TYPE

***TYPE 916** — 12 watts.
Prim: 8500 ohms P.P. (with screen taps)
Sec.: 916-8: 2 or 8 ohms.
916-15: 3.7 or 15 ohms.

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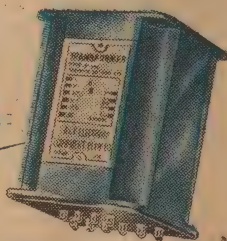
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Gadgets and circuits which we have not actually tried out, but published for the general interest of beginners and experimenters.

SPEECH LIMITER FOR AMATEUR PHONE TRANSMITTER

Our contribution this month is from Mr. W. H. Murden (VK3TY) of 37 Lansdown St., Sale, Victoria and is intended mainly for other amateurs. It is a design for a speech limiter/compressor for attachment to the modulator, making possible a considerably greater depth of modulation without increasing the risk of overmodulation.

THE value of judicious peak limiting, compression, and clipping is well known and devices of this kind are frequently used in commercial installations. However, in amateur stations, far too few take advantage of the idea to increase their effective audio signal by from 3 to 10 db.

Each system is effective, and whilst a clipper is, on paper, the easiest to put into operation, a really effective low pass filter, which is so essential, is far from easy to build with the facilities in many amateur stations.

Attention was therefore directed toward a system which would give limiting and/or compression, depending on the setting of the controls. No originality is claimed or implied in this device but being in the position of having access to adequate test equipment the author has been able to combine much previously published data to produce the accompanying circuit.

CIRCUIT DETAILS

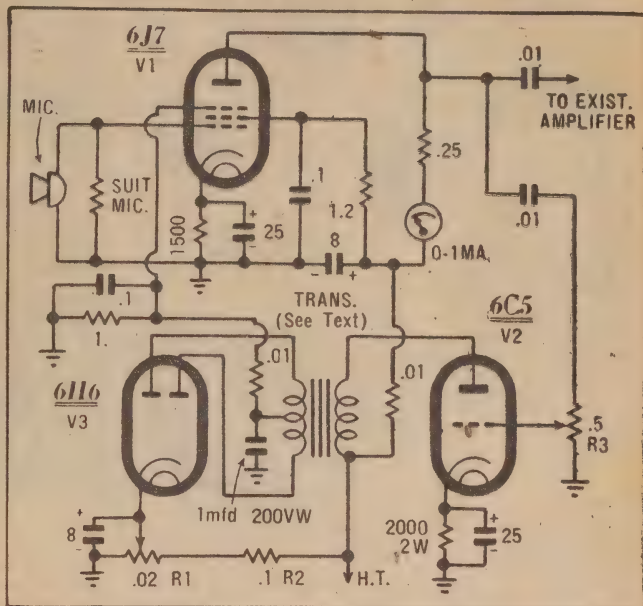
Examination of this circuit will reveal that the basic principle is very similar to the AVC in an ordinary radio receiver.

V1 is the existing pre-amplifier in the modulator and the only changes needed are to remove the existing suppressor grid to cathode connection and connect the suppressor grid to earth via a 1 meg. resistor. The control voltage is fed to this suppressor grid.

Although a 6J7 is shown in the circuit, any similar type of valve can be used, such as the 6SJ7, 6AU6, or the more recent EF86.

V2 is any available triode or triode-connected pentode and functions as a control voltage amplifier. The output of this stage is fed through a small class B transformer to a full-wave rectifier. There is nothing special about the transformer; a cheap battery type class B version being quite adequate.

V3 is the rectifier and may be a 6H6 or any multi-element valve which includes a pair of diodes. A noisy reject in the 6B6, 6Q7, and



similar series is perfectly satisfactory.

The delay voltage obtained from the voltage divider R1, R2 determines just when limiting is to start. With the cathode earthed, the unit becomes a 'straight-out' compressor, control voltage being applied at all input levels. Thus R1 becomes a threshold control which determines the level at which limiting will commence.

The actual amount of compression which occurs, at whatever level it does occur, is determined by R3 which varies the signal voltage fed to V2.

The adjustment of these controls is greatly facilitated by the 0-1 mA meter included in the anode circuit of V1, since it indicates the amount of gain reduction being effected. For normal amateur use R3 should be set to a value which gives a reduction of 25 pc or less in the reading of the meter when loud peaks of speech occur.

The setting of R1 should, ideally, be carried out with the aid of a CRO arranged to check modulation. It should be adjusted so that compression commences (i.e., the meter reading starts to decrease) when

modulation reaches approximately 60 pc.

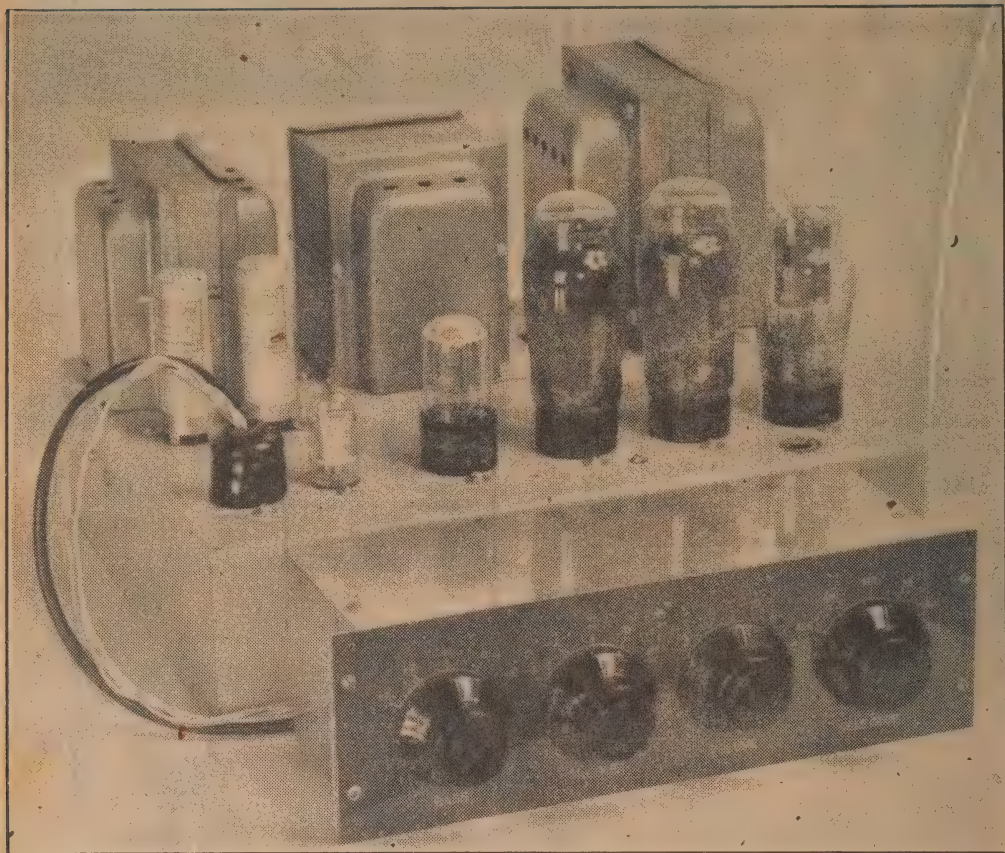
It will be noted that the meter reduces rapidly but takes about one second to regain its normal position, representing a rapid reduction in gain on peaks and a fairly slow recovery. This gives excellent results and is hardly noticeable on the air, but the increase in modulation depth is most noticeable.

Finally, attention should be paid to the following points: The modulator must be capable of handling at least sine wave modulation up to 100 pc without overload, giving an appreciable reserve of power output under normal conditions.

The hum and residual noise must be kept low as it will be increased by the amount equal to the amount of compression used.

It is desirable to use an over-modulation indicator such as a CRO or the familiar rectifier valve and milliamp meter as described in many of the earlier ARRL and similar handbooks.

With compression, over modulation, if it does occur, will cause terrific splatter, BCI, &c., and is likely to invite attention by the authorities.



A photograph of the amplifier together with the Playmaster Control Unit No. 5 with which it was used. It is suitable for all Playmaster units. The valves are EL37's, although 6L6's can be used without change.

17W. ULTRA-LINEAR AMPLIFIER

In this article the discussion concerning the Ultra-linear circuit continues, and a high quality amplifier is described of a type evolved during our experiments. Its response is flat from 20 cycles to 80 Kc, maximum output 17 watts, intermodulation distortion 1 per cent at 14 watts and transient response particularly good. It has been arranged to suit the Playmaster tuning and control units.

IN last month's issue we published an article describing some tests made with the so-called ultra-linear or partial triode circuit.

This circuit was applied to the push-pull output stage of an audio amplifier using pentodes or beam power valves. Essentially it consists of connecting the screens on either side to tapings on the output transformer so that they are connected across portion of the output load.

The method of connecting such

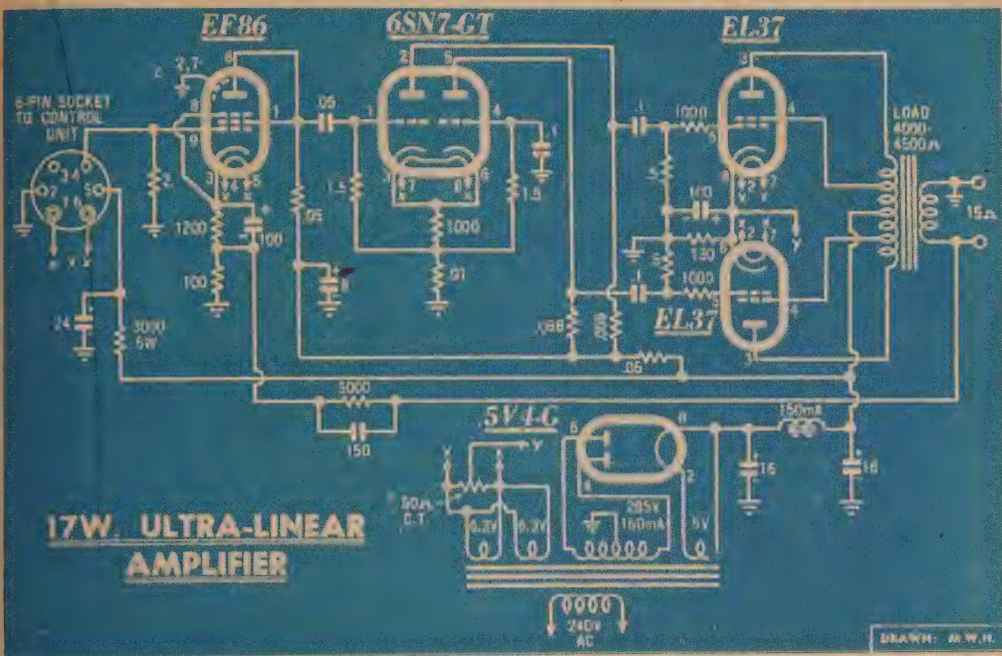
valves for use as triodes is to wire the screens and plates directly to-

by John
Moyle

gether so that both these elements operate as the anode. Tapping the screens part way down the transformer winding causes the valves to operate partly as pentodes and partly as triodes, with some of the characteristics of each.

With the screen tapped at some point between 10 and 25 pc of the load impedance, it was found that the output impedance of the valves was lowered, the power output reduced for some types of valves, and distortion lessened to a figure com-

CIRCUIT DIAGRAM OF ULTRA-LINEAR AMPLIFIER



The filament windings are shown connected in parallel as some transformers may have ratings limited to 2 amps each. A slight overload on filament ratings is not usually serious. Feedback values are for 5 ohms voice coil impedance. Slight discrepancies in power output figures mentioned in this article are due to small changes in high tension voltage at the time of the tests. Plate to cathode voltage in this amplifier was a little over 260 volts.

parable with that of triodes.

When applied in practice to an amplifier using a pair of 6BW6 valves in push-pull which as pentodes delivered 10.5 watts to the transformer secondary, output fell to about 6.2 watts. The output impedance was reduced to a figure closely approaching that of the valves operated as triodes, and the intermodulation distortion curve up to the maximum output of the ultra-linear circuit was appreciably lower than that for pentode connection.

The sensitivity of the output stage was also reduced, being lowest with the highest screen tapping, but it remained substantially higher than for the triode circuit.

LOW OUTPUT

The net result was an amplifier with much better characteristics than the original pentode type, but with an output reduced to a figure generally considered as being rather low for a high quality job.

Preliminary tests with a similar amplifier using higher powered valves such as the 6L6 and the EL37 indicated that an output between 10 and 20 watts could be obtained without greatly increased cost. In the case of the EL37's, power output remained substantially the same as for pentode connection.

This, it was suggested, may have

been due to the higher Gm of the EL37, and the more favorable characteristics of the screen circuit which might be found with such valves. The article concluded by forecasting further work on the larger amplifier, the results of which it is proposed to discuss here.

MANY TRANSFORMERS

To assist in this work, quite an array of output transformers was assembled to which nearly every manufacturer supplying special types to the public contributed. These included several output impedances

ranging from 4000 ohms to 6600 ohms plate to plate, and screen tapplings from 5 to 25 pc of the plate impedance each side of the centre tap.

The amplifier itself was wired to several combinations of input and phase-changer circuits, and the circuit to be described later was evolved as being the most promising for our purpose, which was to provide a suitable type for use with the Playmaster series of tuning and control units.

We have not actually classed this as a Playmaster amplifier because we feel there are certain aspects of

PARTS LIST

- 1 Chassis as used for No. 1 Player-mester.
1 Power transformer 285/285v, 150 mA secondary standard type.
1 Filter choke 10-20 Henries 150 mA.
1 Output transformer 4500 ohms plate to plate load to suit speaker with taps for ultra-linear connection.
Valves 2 EL37, 1 6SN7, 1 EF86, 1 5V4G.
Electrolytics 2 16 mfd 600v, 1 24 mfd 350v, 1 8 mfd 350v or higher, 2 100 mfd 40v.

- Paper condensers all 400v or higher—
3 .1 mfd, 1 .05 mfd.
1 150pf mica condenser.
Resistors $\frac{1}{2}$ watt—2 1.5 megs, 1 2 megs,
2 .5 megs, 1 68K, 1 56K, 2 50K, 1
10K, 1 5K, 2 1K, 1 1.2K, 1 100 ohms
1 3K 5-watt resistor.
1 130 ohms 3-watt resistor.
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SOME PERFORMANCE CURVES

the circuit yet to be fully investigated, and some new valve types not yet released here which may be used to even better advantage.

Nevertheless, as our data indicates, this amplifier is of extremely high quality and shows quite clearly that the ultra-linear circuit is probably the best method yet devised of using pentodes. It may even be better than the standard triode circuit in its ability to produce low distortion output, and preserves most of the high efficiency which makes pentodes so valuable.

Concerning power output the EL37 has demonstrated that for any percentage of screen tapping we used, it can deliver approximately the same amount as a pentode or as an ultra-linear valve. In general, its output is slightly better in the latter connection. This result was observed quite consistently with various transformers, including an English Partridge type which has a high reputation for quality.

6L6 PERFORMANCE

On the other hand the 6L6, representing perhaps the most practical alternative type, demonstrated just as consistently a drop in output to between 65 and 70 pc of its pentode power. In this it appeared to follow the 6BW6-6V6 pattern.

Both types were operated at about 260 effective plate volts, for which a similar bias and output load is specified. It was possible therefore to make a direct replacement one for the other without substantially upsetting the optimum conditions for each.

In general the only difference of any note between them was the reduced output power from the 6L6's. They have a G_m of about 6 as against 11 for the EL37. The distortion figures measured for each type showed minor differences but, because of the superior performance of the EL37, measurements with the 6L6 were not carried through.

Tests with valves such as the EL34 indicated that although there was some drop in output, it might not be severe. But these valves are in another and higher power class.

Our comment here, however, must be that, because of the complex nature of what is really a new type of valve when used in the ultra-linear circuit, it is unwise to be dogmatic until a much fuller examination of ultra-linear operation can be made.

MUST WAIT

It was intended to make an exhaustive analysis using a special transformer with a wide variety of screen tapplings with as many valve types as possible, but we quickly realised the immensity of the task, as no check on behavior is worth much without a distortion measurement for each change in setting.

The main complication in the issue is the fact that the screen, an erstwhile "silent partner" in the business of power output, has now assumed an active function. Being connected across part of the load, it delivers power into it, but at the same time it is driven by the audio voltage developed at the tapping point. It also complicates the electrical behavior of the load which is now shared between two elements.

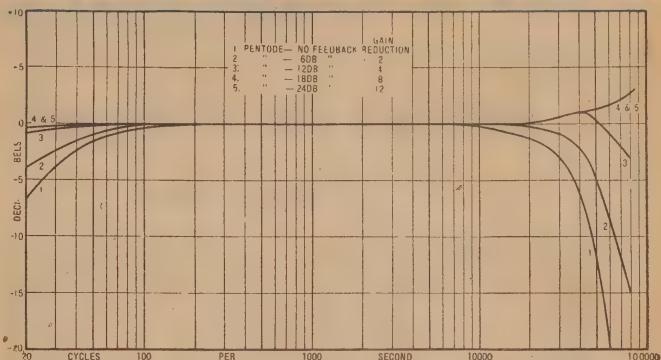


Fig. 1. These curves show the changing amplifier response as feedback is applied using one of the test transformers in pentode connection. Note the emergence of the high frequency peak which is aggravated by a large amount of feedback.



Fig. 2. The same amplifier tested using an ultra-linear tap on the transformer. The final curve is virtually flat from 20 cycles to 80 Kc.

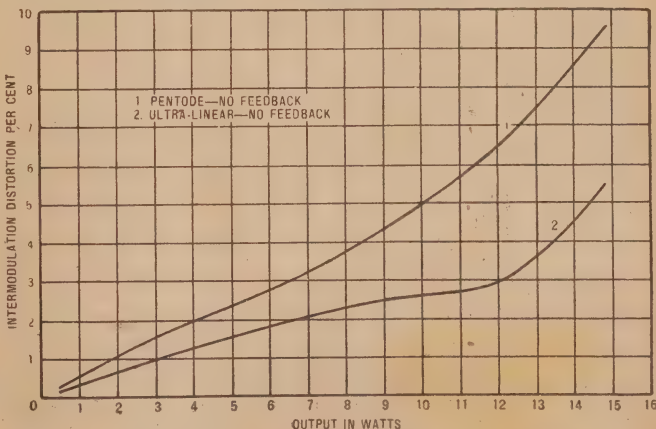


Fig. 3. This curve shows comparative IM distortion with a transformer wired for pentode and ultra-linear. No feedback was used. Other transformers showed a greater improvement for the ultra-linear connection.

and modifies the response curve of the amplifier as will later be shown.

There is negative feedback applied to the screen of the valves because of their connection to the

transformer, and their altered characteristics are due to this effect. The amount of feedback will vary according to the position of the tap, being greatest when the screen and plate

STANDARD



RANGE

RECEIVER POWER TRANSFORMERS

CODE NO	PRIMARY VOLTS	HTV aside	HT mA	FILAMENTS	
PF185	240	150	30	6.3V/2A	
PF299	240	285	40	6.3V/2A, 5V/2A	
PF300	240	325	40	6.3V/2A, 5V/2A	
PF201	240	225	50	6.3V/2A	

NOTE: All transformers are available with upright mounting. The following 9 transformers are also available with flat mtg., fitted with an adaptor plate to suit 3 x 3/16" centres. On removal of plate, mtg. centres become 2 1/2 x 3 1/8-in. IF flat mtg. is required affix Code No by letter F e.g. PF151F.

PF151	230, 240	285	60	6.3V/2A, 5V/2A	
PF166	230, 240	325	60	6.3V/2A, 5V/2A	
PF165	230, 240	385	60	6.3V/2A, 5V/2A	
PF170	230, 240	285	80	6.3V/2A, 6.3V/2A, 5V/2A	
PF169	230, 240	325	80	6.3V/2A, 6.3V/2A, 5V/2A	
PF168	230, 240	385	80	6.3V/2A, 6.3V/2A, 5V/2A	
PF130	230, 240	285	100	6.3VCT/2A, 6.3V/2A, 5V/2A	
PF164	230, 240	325	100	6.3VCT/2A, 6.3V/2A, 5V/2A	
PF160	230, 240	385	100	6.3VCT/2.5A, 6.3V/2A, 5V/2A	

PF152	230, 240	285	125	6.3VCT/3A, 6.3V/2A, 5V/2A	
PF163	230, 240	325	125	6.3VCT/2.5A, 6.3V/2A, 5V/2A	
PF181	230, 240	385	125	6.3VCT/2A, 6.3V/3A, 5V/2A	
PF174	230, 240	285	150	6.3VCT/2A, 6.3V/2A, 5V/2A	
PF142	230, 240	325	150	6.3VCT/2A, 6.3V/2A, 5V/3A	
PF175	230, 240	385	150	6.3VCT/2A, 6.3V/2A, 5V/3A	
PF167	230, 240	385	150	6.3VCT/2A, 5V/3A, 2.5VCT/5A	
PF173	230, 240	425	175	6.3VCT/3A, 6.3V/2A, 5V/3A	
PF140	230, 240	385	200	6.3VCT/3A, 6.3V/3A, 5V/3A	
PF171	230, 240	385	250	6.3VCT/4A, 6.3V/3A, 5V/3A	

POWER AMP. AND LOW POWER T/MITTER UNITS

PF172	230, 240	500	200	6.3V/4A, 6.3V/3A, 5V/3A	
PF143	230, 240	600/500	200	2.5V/5A, 2.5V/5A, 5.5V/5A	

PF147	200, 230, 240, 260	1000, 750, 500, 300	200, 250, 300	5.5V/3A	
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PF179	230, 240	475	225	6.3VCT/4A, 6.3V/2A, 5V/3A	
PF107	230, 240	585	250	6.3V/3A, 6.3V/2.5A, 5V/3A	

C.R.O. TRANSFORMERS

PF188	240	350 one ext. 900	30 2	6.3V/2A, 6.3V/1A 5V tap 4V/2A 4V tap 2.5V/2A	
PF545	240	350 one ext. 1000	20	6.3V/3A, 6.3V/6A, 4V tap 2.5V/2A	

TAPE-RECORDING TRANSFORMERS

PF642	230, 240	250	80	6.3V/3A, 5V/2A Low radiation	
PF664	230, 240	265	80	6.3V/3A, 5V/2A Low radiation	

PHOTOFLASH TRANSFORMERS

HT119	200	4000 1/2 wave			
HT131	240	1100 1/2 wave		prim. also vib. 5.2 or 4V	

POWER CHOKES

CODE NO.	IND. HY.	DC RES.	DC MA.	CODE NO.	IND. HY.	DC RES.	DC MA.
CF100	50	1900	10	CF112	10	70	1250
CF101	30	870	25	CF113	5/20	70	50/250
CF102	15	300	60	CF115	.017	.6	2A
CF103	30	420	60	CF119	.005	.1	6A
CF104	30	580	80	CF162	10	90	330
CF105	15	250	80	CF196	20	130	125
CF106	12	200	100				
CF107	30	360	100	CF114	10 watt fluor ballast		
CF108	12	135	150	CF213	20 watt fluor ballast		
CF109	20	225	150				
CF110	12	100	200				
CF111	16	165	200				

* Fitted with rubber mounting to reduce hum. Standard 5/16" hole centres.

VIBRATOR AND A.C. POWER TRANSFORMERS

CODE NO	PRIMARY VOLTS	HTV aside	HT mA	FILAMENTS	
PF182	240AC 12VIB	200	40	12.6/1A	
PF122	240AC 6VIB	220	40	6.3V/2A	
PF125	240AC 6VIB	250	60	6.3V/2A	
PF126	240AC 12VIB	250	60	12.6VCT/1A	
PF119	240AC 6VIB	325	125	6.3V/4A	
PF146	200, 230, 240 AC 12VIB	325	150	12.6VCT/2.5A	

VIBRATOR TRANSFORMERS

CODE NO	PRIM VOLTS	DC Volts	O'put Buffer m/A	Full Sec	
VT101	6	90	15	.008	
VT102	6	150	25	.005	
VT103	6	200	50	.005	
VT127	6	200	50	.005	Low radiation. Car Radios
VT104	6	250	60	.005	
VT107	6	250	60	.005	Low radiation. Car Radios
VT106	6	300	75	.008	
VT122	6	400	50	.005	
VT146	12 or 6	240AC	50w	IMPD	For Emergency light, etc.
VT112	12	200	50	.005	
VT132	12	200	60	.005	Low radiation. Car Radios
VT105	12	250	60	.005	
VT117	12	250	60	.005	Low radiation. Car Radios
VT114	12	300	75	.008	
VT123	12	320	125	.005	
VT113	24	200	50	.005	
VT116	24	250	60	.005	
VT115	24	300	75	.008	
VT119	32	150	25	.005	
VT100	32	200	40	.005	
VT124	32	250	60	.005	

FILAMENT TRANSFORMERS

CODE NO	PRIMARY VOLTS	SEC. VOLTS	
PF118	220, 240, 260	2.5V/5A, 2.5V/5A	
PF158	220, 240, 260	5V/8A	
PF476	240	6.3V/3A	
PF138	220, 240	6.3V/4A, 5V/4A, 2.5V/4A, 2.5V/4A	
PF162	240	6.3V/3A, 6.3V/3A	
PF154	200, 230, 240	7V tap 6V/7A, 6.3V/3A, 5VCT/5A 5V/3A, 2.5V/7A	
PF102	240	7.5V/2A	
PF111	240	10V/5A	
PF211	200, 230, 240	10VCT/10A	
PF131	230, 240	10VCT/10A, 5V/15A	
PF123	240	15, 12, 8, 6V/1.8A	
PF439	240	32V 60W Enclosed one outlet	
PF457	240	32V 125W Enclosed two outlets	
PF491	240	32V 200 W Enclosed two outlets	

BATTERY-CHARGING TRANSFORMERS

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are tied together so that the valve behaves like a triode. In pentode connection, with the screen tied to the high tension supply, there is naturally no screen feedback at all.

Consequently the valve geometry as it concerns the screen is something which needs study by a valve engineer who is able to assess and interpret the operation of the circuit from this point of view.

BIG JOB

In other words, it calls for a full laboratory series of tests which we frankly admit is beyond us at present. At the same time certain tendencies have been observed in the work to date which give reasonable validity to some conclusions, and point the way to probable results in others.

In order to show the effect of ultra-linear on the output transformer, we ran a series of curves for both pentode and ultra-linear connection with varying degrees of feedback, for the application of feedback has such a large effect on amplifier performance that the two must be observed together.

The curve of Fig 1 shows the gradual modification of the response curve, and the emergence of the resonance peak which is characteristic of most output transformers in such a circuit. The generator used had an upper limit of 80 Kc so that the peak in curves 4 and 5 is probably just above 100 Kc when fully developed.

The effect of this peak is to cause appreciable ringing and overshoot during square wave tests. Both were present in pronounced form for these two curves, and could not be suppressed by a bypass on the feedback resistor to the voice coil without appreciably degrading the waveform.

In this connection it may be observed that, for all the transformers tested, there was an optimum degree of feedback which produced the best compromise between response and ringing. These curves illustrate the doubtful value of excessive feedback with pentode amplifiers, so often used under the impression that the results must be best with most feedback.

OPTIMUM FEEDBACK

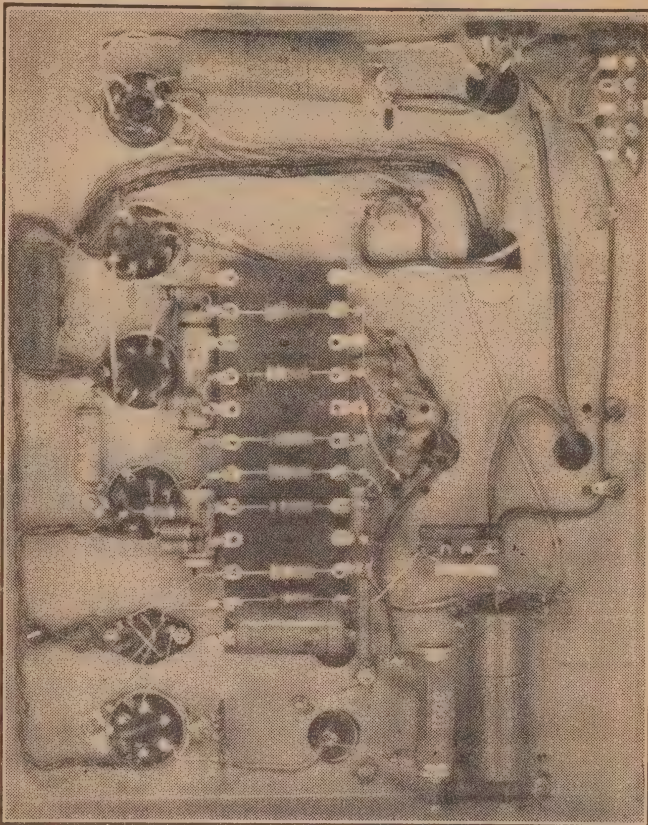
As a matter of interest it might be noted that about 15 db of feedback was the optimum amount with the transformers tested, representing a gain reduction of about 6.5-1.

It is obviously bad practice to use excessive feedback with a poor transformer in an attempt to make it a good one. Such a transformer would show a high peak probably lower down in the audio range, followed by a sharp roll-off. These conditions set up bad ringing, and in many cases high frequency oscillation, which can only be cured by drastic degradation of the response curve and an equal degradation of transient response.

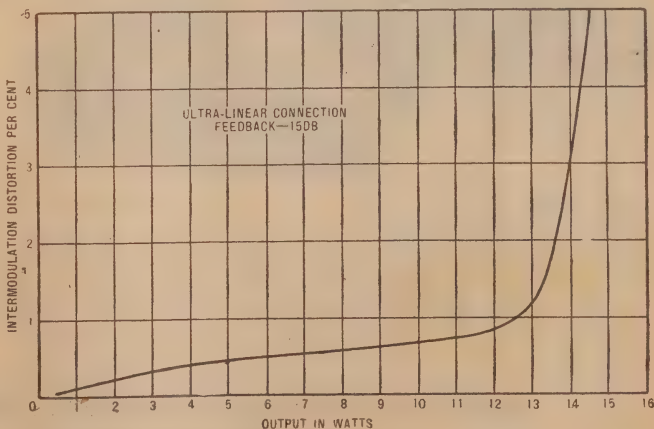
It might even be suggested that any amplifier which needs more than about 15 db of feedback to correct for the output transformer is not good enough initially to be classed as really high quality.

The curves of Fig. 2 are for the same amplifier and transformer using an ultra-linear connection at 19 pc. It is immediately apparent

AMPLIFIER UNDERCHASSIS VIEW



This underchassis picture shows almost every component and much of the amplifier wiring.



Curve showing IM distortion for one of the amplifiers. The slight upward bend over the major portion indicates that some external pick-up may have been adding to the reading at low percentages. Total harmonic distortion will probably be about 20 pc of IM distortion figures.

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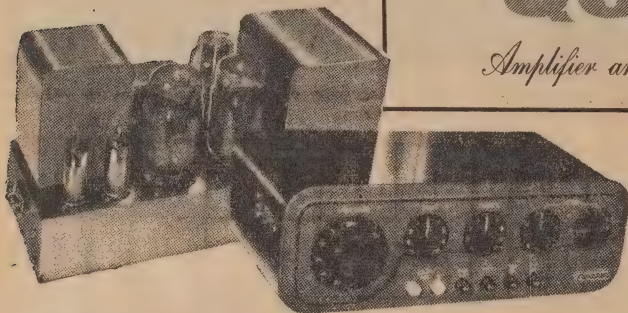
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that the peak shown for the pentode connection has not materialised at all, and that the curves for 18 and 24 db indicate virtually a flat response which is most impressive.

It is probable that some movement between 100 and 200 Kc, but a natural attenuation in that region would reduce its significance, and a small phase correction condenser across the feedback resistor would almost certainly remove it from any possible danger point. In neither case was there any tendency toward oscillation, indicating no positive feedback at any stage.

This general pattern was repeated with all the transformers tested. In one case a 6 db peak at 60 Kc, which brought the amplifier perilously close to oscillation, was reduced to one of 1.5 db with a sharp

greater effect. We indicated by curves how the behavior of an ultra-linear connection with feedback was almost indistinguishable from triodes in this respect, and is good enough for us to accept it as quite satisfactory for the moment. Whether any further improvement would be worthwhile in practice is really the subject of another form of study.

For a series of preliminary tests of this nature, it is obviously impracticable to attempt a harmonic analysis of every test condition, of which there might be dozens by the time all the combinations of valves, circuits, and transformers were considered. At this stage, therefore, we limited ourselves to intermodulation tests applied to the most promising conditions.

These tests are valuable because not only do they show perhaps the

ELECTRIC GUITARS ... MIKES and ... AMPLIFIERS



An oscillogram of the amplifier described here when fed with a square wave at 10 Kc. The amount of ringing visible on the flat tops is virtually negligible.



An oscillogram of the amplifier taken through No. 5 control unit in the 78 position in which there is no top cut in the compensation or roll-off in the bass. The slope of the flat tops is due to the bass boost of the amplifier. There is evidence of the slightly poorer high frequency response, but the ringing has almost disappeared. The frequency was 10 Kc.



This square wave pattern at 1000 cycles through the amplifier is virtually a duplicate of the generator output, and no overshoot or ringing is visible. The slight rounding of some corners should be remembered when observing the other patterns shown here.

attenuation immediately following. This transformer showed a greater tendency toward ringing than the one represented by the graphs, but it was quite stable.

GOOD RESPONSE

In all these cases, 15 db of feedback was sufficient to bring the response to an optimum characteristic, and in the case of two types to produce curves with no variation worth recording between 20 cycles and 80 Kc.

We make no attempt at this stage to estimate how good an amplifier need be in matters of this kind to sound well when connected to a pickup and loudspeaker. Our purpose has been purely one of investigation to find out how an amplifier behaves under different operating conditions.

The lessons learnt from our own tests and the experience of others may well be used with benefit for designs of the future.

We have already shown in last month's issue that the ultra-linear circuit gives a much lower output impedance than the pentode circuit, and that the use of even moderate amounts of feedback has an even

most important distortion tendencies of an amplifier, but they also indicate a probable total harmonic distortion which can be estimated as 20-25 pc of the IM figure. It is obvious, therefore, that an IM distortion of, say, 1 pc, means a very low amount of distortion of any kind.

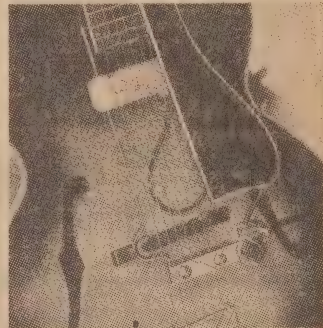
LOW IM DISTORTION

The amount of IM distortion in the final amplifier was so low that the conditions under which it was measured probably did not allow accuracy at fractions of 1 pc. It is probable also that extremely careful adjustment and balance of the amplifier would have been necessary to allow the full comparison between ultra-linear and pentode connection to emerge, particularly over the main operating range of power output.

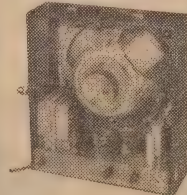
We know, for instance, that unbalance of the output valves can cause appreciable increase particularly in second harmonic distortion,



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but we did not observe any great increase in the measured IM figure when the output stage was deliberately unbalanced, or the balance between the driving source upset.

It was anticipated, also, that the use of separate cathode bias resistors for the output stage would reduce the IM distortion, but our figures did not indicate this.

We can reasonably conclude, however, that the points mentioned are probably significant for fractional percentages of distortion, but are not likely to prejudice the operation of the amplifier when built outside a laboratory. The fact that the IM distortion was below 1 pc almost up to the maximum power output of the amplifier means that although it is a good thing to eliminate any possible source of distortion, we need not go to extremes to obtain a high grade of performance.

In order to compare the distortion obtained from pentode and ultra-linear connection we made comparative tests with various transformers and with varying conditions of load. Mostly these were done without feedback in order to accentuate the difference for easier measurement, and to avoid the difficulty of exact adjustment of feedback for every set of readings.

On a comparative basis, we had some difficulty in presenting a fair case, as the differences were much greater with some transformers than with others, and varied with changes in output load more than was expected.

It may be, therefore, that although the ultra-linear connection invariably showed the better figures, more work could be done to establish optimum load conditions and tapping points as related to distortion. It was here that a more detailed harmonic analysis would have been valuable, as indicating exactly what type of distortion was varying with changed conditions.

For instance we know from the results of tests made by others that the third harmonic distortion is very greatly reduced by an ultra-linear circuit, and in some cases virtually eliminated. The second harmonic distortion is not materially affected, but this can also be reduced to a small amount by careful balance.

PUBLISHED STANDARD

At the same time it might be argued that if we can maintain an IM of below 1 pc over the useful operating range, any further reduction is more of academic interest than otherwise. According to the Radiotron Designer's Handbook, 2 pc IM is permissible for a "very high fidelity amplifier", and as fig. 4 shows, this amplifier does not exceed this amount until overload is reached.

However, the curves shown in Fig. 3 indicate a fairly representative test for one of the best transformers, although under other conditions the variation was many times greater. It should be safe to say that a 2-1 improvement in IM is not too much to expect, with ultra-linear connection, and that with more accurate adjustment this result should be improved upon.

Both these curves were taken without feedback. Incidentally the shape of the ultra-linear curve, with a rise in the centre, where we might have expected the reverse, lends

support to the view that some of the distortion at low levels was not all contributed by the amplifier.

Fig. 4 is the IM curve of the amplifier with 15 db of feedback, and was taken with 250 volts between the plate and cathodes of the EL37's. With modern high efficiency loudspeakers, most of our listening will be done in the region from zero up to 2 watts, and through this range distortion is scarcely measurable.

Considering the circuit on page 57, it is in the main simple and straightforward. It has only a single feedback loop from the voice coil to the cathode of the first valve, a method now almost universally adopted, particularly when only one loop is used.

PHASE CHANGER

The phase changer is generally known as the "cathode coupled" type because the coupling between the two sections of a twin triode is made via a 10K resistor common to both cathodes.

The grid of the second or phase inverter section is earthed for audio through a fixed condenser, thus precluding any possibility of drive being applied to its grid.

The rise and fall of plate current of the first section is controlled by audio voltages fed to its grid from the EF86.

Assuming that the grid of the first section is driven with a positive voltage, the effective negative grid bias will be lessened, the valve will draw more plate current, there will be a higher voltage drop across the plate resistor, and the plate itself will become less positive. The output valve on its side of the circuit will, therefore, receive a negative-going signal.

The increase in plate current of the first section automatically means that the current through the cathode resistors will also increase. There will be a greater voltage drop across the 10K resistor, and the cathodes of both sections will become more positive.

A higher positive voltage on the cathode of the second section is the same thing as a higher negative bias on the grid, which will reduce its plate current. A fall in plate current means that there will be less voltage drop across the plate resistor, and the plate will become more positive. Therefore, the signal applied to the output valve driven by the second half of the phase-changer will be positive going—opposite in potential to that of the first.

Thus we have obtained the necessary push-pull action from the phase inverter.

CHECKING BALANCE

The circuit will only operate if there is a difference in plate current between each half of the inverter. As a result the plate resistors are of unequal value. In this circuit the difference will amount to about 12 or 15K, but the exact value will depend upon how closely the plate currents of the two valves are matched in the first place.

A small unbalance was not found to have an appreciable effect on IM distortion.

A simple and accurate way to obtain exact balance is to measure

(Continued on Page 109)

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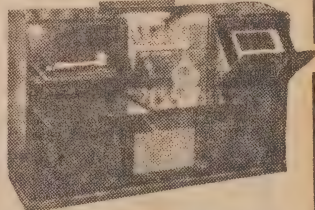
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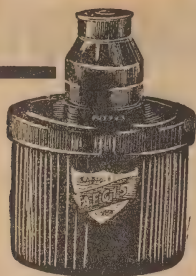
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DETECTORS—AND HOW THEY WORK

One subject which many beginners find difficult to follow is the functioning of the detector circuit. A clear understanding of this is vital before the student can progress very far with his studies and, in this article, we have endeavored to explain the operation in simple language.

IN order to understand fully the action of a detector, it is first necessary to appreciate the actual form of a signal radiated from a transmitter.

Under conditions of no signal, as for example between program items or when a transmitter is being tested before a program comes on the air, the only signal being radiated is what we call the "carrier."

This is a perfectly steady radiation of RF power. It is created at the transmitter by means of an alternating current, similar to that found in the mains, except that it is so many times faster. Whereas the mains operate at 50 cps, a station in the middle of the broadcast band would generate an alternating current at something like one million cps.

When the signal is received from the transmitter it produces a similar alternating current in the tuning circuits of our receiver. We may even amplify this alternating current until it is many hundreds of times stronger than when it was received by the aerial. But, if we feed it to a loudspeaker or headphones in this form, it will be of no use whatever.

EAR LIMITATIONS

For one thing our ears are quite incapable of hearing such a frequency, even assuming that the loudspeaker or earphones we were using were capable of responding to it, which they are not.

But even assuming we could hear the signal, it would not be of any value because it is not carrying any useful information. In other words, it is not modulated.

Before we can use the carrier to convey intelligence to the listener, we must vary it in some manner which the listener can both observe and understand. There are several methods of varying, or modulating, the carrier, but the most popular at present is to vary the strength, or amplitude, giving rise to the term "amplitude modulation".

The easiest way to understand this is to visualise what would happen if we were to modulate the carrier with a steady tone of, say, 1000 cps.

This would cause the amplitude of the carrier to vary 1000 times per second and, assuming that we modulated the carrier to the maximum possible degree, the amplitude would vary between zero and twice the normal, unmodulated level. Such a condition is known as 100 pc modulation.

The accompanying diagram (figure 1) portrays this graphically and you will observe that each succeeding RF wave in the modulated portion varies from its neighbor in amplitude; the general contour made by these peaks representing the shape of the modulating wave.

And what has all this to do with detection? Simply this: the carrier, although now carrying a signal, is still of no use to the listener. We may arrange tuned circuits to respond to the carrier and valves to amplify it but, if fed to a speaker in its present form, there would be no sign of the 1000 cps note which we know is really there.

The main reason for this is that our ears are not capable of detecting the presence of the carrier and obviously, they cannot appreciate either the changing amplitude representing the 1000 cps note.

SECONDARY CAUSE

There is also the limitation of the average loud-speaker, which will not respond to the carrier; however, this fact is not really vital. It might conceivably be possible to construct a loudspeaker which would work at the carrier frequency, but this would not alter the fact that the modula-

Now the ear is, in part, a simple mechanical device consisting of a drum or diaphragm which responds to variations in air pressure by vibrating in sympathy with them. As with any mechanical system there is a limit to the speed at which it can vibrate and, once this speed is passed, the response is nil.

A too-rapid change in pressure will act on the drum for such a short period that the latter will not have time to move before the pressure is reversed and it must try to move in the opposite direction. As a result it will not move at all, the successive pressure changes occurring so close together that, as far as the slow moving drum is concerned, they simply cancel out.

In practice, the impulses would not get past the speaker, which would suffer the same limitations as the ear. Any impulse which tried to move the cone in one direction would be followed so rapidly by the opposite wave that there would be no movement at all.

But suppose that the speaker (or ear, drum) having been subject to, say, a positive-going pulse was not subjected to the opposing (negative) pulse, which normally follows it. Instead, let us suppose that this negative pulse is suppressed and that only positive pulses are used.

Since an RF signal is in the form of an alternating current, we can suppress one side of it quite easily by passing it through a "rectifier". This term describes any device which will pass current more readily in one direction than another.

Now we have quite a different picture. With the cone (or ear drum) receiving a series of impulses which are always in the same direction, it eventually decides to get a move on and follow the directions of these impulses.

Assuming that the speaker was connected to such a circuit, the presence of an unmodulated carrier would cause the cone to take up a position to one side of its normal "at rest" position, the amount of deviation depending on the strength of the carrier.

This is just what we would expect, and it is also, easy to appreciate that a change in carrier strength would cause the cone to take up yet another position and, in fact, it would follow every variation of carrier strength.

This is just what we require because the signal we wish to receive (the 1000 cps note) is in the form of changes in carrier strength at this frequency.

Thus, the process which we call "detection" is really only a specialised form of rectification, the term detection being reserved for the process of extracting signals from a carrier.

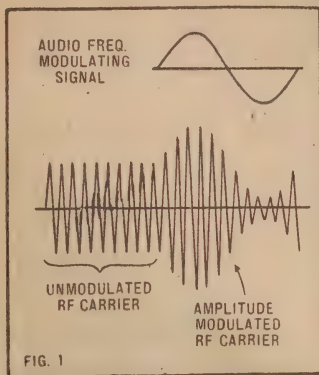


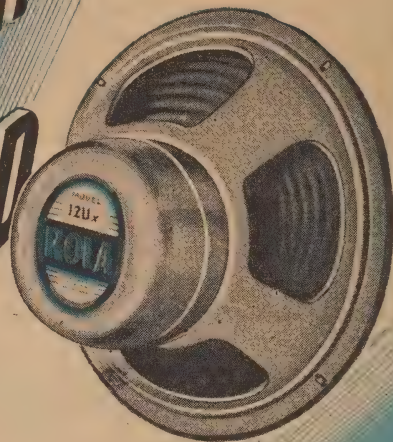
FIG. 1
An RF carrier wave, showing how modulation varies the amplitude. Above the modulated portion is the audio signal which produces it. In practice the RF waves would be very much closer together than can be shown here.

tion on the carrier would still be inaudible.

To get a better understanding of this limitation let us look closely at the carrier signal once again. Generated in the form of an RF alternating current it consists of a current flowing first one way and then the other.

If this were converted into mechanical energy by a loudspeaker, it would reach our ears in the form of variations in air pressure, first an increase in air pressure above normal and then a partial vacuum below it, and these variations would follow each other with extreme rapidity.

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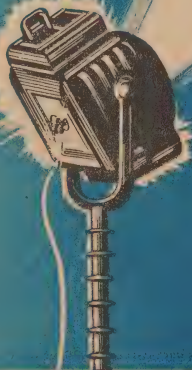
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In practice our signal, after detection, may have to pass through audio amplifying stages before reaching the speaker and these stages would not amplify the steady signal produced by the unmodulated carrier.

This is of no importance because we are only interested in the CHANGES in carrier strength, not its steady value. The audio amplifier will readily handle these changes at all important frequencies so that the wanted audio signal is preserved.

At this point we have another problem to consider. The signal we have transmitted is in the form of a series of RF pulses having varying peak amplitudes, the general contour of these peaks providing the shape of the wave we are transmitting.

But, you may reasonably ask, what about the spaces in between the RF peaks. Do not these represent "gaps" in the signal?

Yes, as a matter of fact, they do, but this is not as serious as

between the carrier and the modulation it is easy to select a capacitor large enough to retain its charge from one RF pulse to the next, yet small enough to charge or discharge with the relatively slow changes in carrier amplitude representing the modulation.

One of the main reasons for filtering out this RF component is to prevent it reaching the audio amplifying stages of the receiver, where it may be amplified along with the audio signals and reach such proportions as to cause instability in the receiver.

Coming to the more practical side of things we find that there are many types of rectifiers which may be used for detection.

SIMPLE DETECTOR

One of the first most of us encounter is the "crystal" used in the simple crystal receiver. These "crystals" are substances which have the natural characteristic of passing current much more readily in one direction than another.

Some occur as mineral deposits and others are manufactured. In general the manufactured types appear to be more efficient than the natural types.

Copper oxide is another well-known substance used for rectification and devices using this material range from those intended as detectors up to very large units handling hundreds of amps. Other well-known rectifiers are selenium and, of course, the "wonder" material, germanium. These are only a few and there are many more which have this property to a greater or lesser degree.

During the last war, prisoners-of-war constructed crude radio receivers using, among other things, a rusty razor blade and the point of a safety-pin in a kind of crystal and cat's whisker arrangement.

It is doubtful whether the exact operation of this device could be easily explained or even whether it could be duplicated in all cases. Doubtless a lot of chance was involved in obtaining just the right amount of impurities of the right kind for satisfactory operation. However, the fact remains that it worked, at least after a fashion.

PARTIAL SUPPRESSION

It is important to realise that it is not necessary to completely suppress the unwanted halves of the RF pulses. All that is necessary is for one to be stronger than the other, though, naturally, the one providing the most suppression will function most efficiently. Practical detectors may only partly suppress the unwanted pulses and their effectiveness varies considerably from one type to another.

A typical crystal set circuit (Fig. 2) may help to explain how these devices are used.

The incoming signal, in the form of a modulated carrier, appears as an alternating voltage across the tuned circuit (coil and variable capacitor).

This voltage is now applied to the headphones and detector, these being connected in series so that any current which flows through the headphones, as a result of this applied voltage, will also have to flow through the detector. As a result this current will be predominantly in one direction and

will vary with the carrier strength. Note the capacitor across the headphones which serves as the RF filter.

In spite of the improvements in substances like germanium the most popular detector for ordinary radio work is still the valve. This is used in many forms of detector circuit, such as the diode detector, the leaky grid detector, the anode bend detector, the infinite impedance detector, &c.

About the easiest to follow is the diode detector which uses a simple two-element valve, consisting of a cathode and a plate. These elements are frequently mounted in the same envelope as a more complex valve, such as a pentode, but this is purely a matter of convenience.

HOW IT WORKS

In operation electrons are given off from the cathode and will be attracted toward the plate while ever this is positive with respect to the cathode. Thus current will flow through the valve while ever the plate is positive. However, as soon as the plate becomes negative the electrons are repelled and no current will flow.

A typical diode detector circuit is shown in figure 3. In addition to the diode valve itself we have a tuned circuit, normally the secondary of the last IF transformer; a resistor, known as the diode load; and a small capacitor across this resistor to serve as the RF filter.

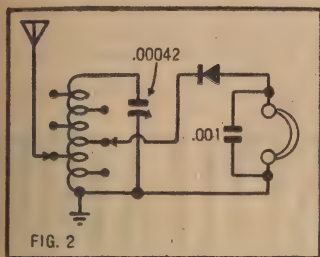


FIG. 2

The simplest of all detectors is that found in a crystal set. The crystal has a natural characteristic which allows it to pass current more easily in one direction than in another.

it may appear. For one thing there are a great many RF waves (many more than we can draw) to a single audio wave. Considering the case of the 1000 cps note modulating a 1 megacycle (one million cycle) carrier, there would be 1000 RF waves to each complete audio wave.

But the important thing is that, in order to reveal these "gaps", the ear, and the speaker, would have to be able to detect changes occurring at the carrier frequency, and this, as we have already shown, is just what they cannot do.

INERTIA

And so the natural inertia of the speaker cone serves to filter out this high frequency ripple in much the same way as the flywheel on a petrol engine irons out the pulses from each cylinder and changes a series of short bursts into a smooth and continuous flow of power.

This RF ripple can also be filtered out electrically. Associated with every detector is some form of "load", either the headphones in the case of simple sets, or a resistor where the detector is to be followed by audio amplifiers.

If we connect a capacitor of suitable value across this load, the charge which it acquires from the initial RF pulse will be sufficient to replace the missing portion of the signal until the next RF pulse arrives.

Due to the difference in frequency

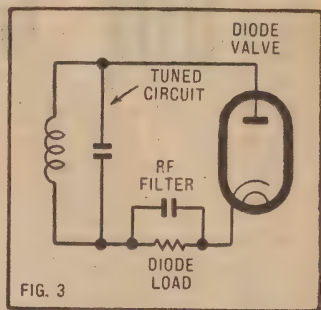


FIG. 3

The basic circuit of a diode detector. The audio voltage is developed across the diode load and applied to the following stage for amplification. Note the filter capacitor which eliminates the RF component.

To understand the operation of this circuit let us assume that, at a particular moment, the RF voltage appearing across the tuned circuit has a polarity such that the bottom of the winding is negative.

Under these conditions the diode plate will be positive and electrons will flow from the bottom of the winding, through the diode load resistor to the cathode, thence by the electron stream to the plate and the upper end of the winding.

A moment later, when the RF voltage changes its polarity, the diode plate will be negative and there will be no movement of current in the circuit. Thus the signal is rectified.

So far we have been thinking

(Continued on Page 89)

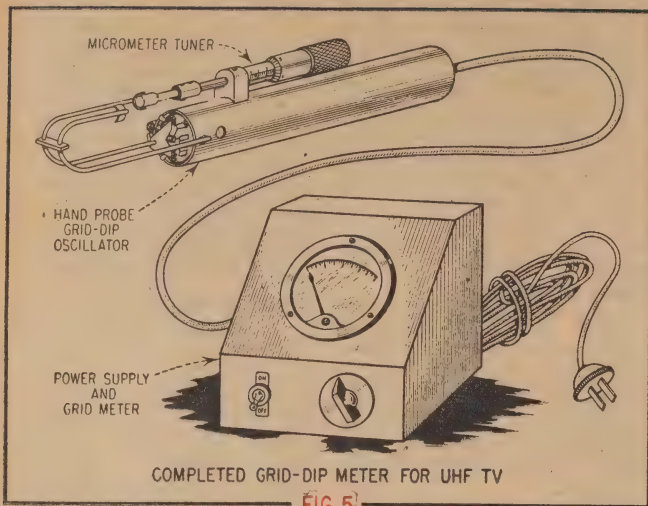


FIG. 5

A UHF GRID-DIP OSCILLATOR

In April, 1953 we published a paper from the Aerovox Corporation detailing the construction of a UHF absorption-type frequency meter. From the same source comes this discussion of the design problems surrounding a grid-dip oscillator for the same portion of the spectrum. The ideas contained in it should be of interest to UHF enthusiasts.

THE UHF absorption frequency meter described in the above mentioned issue fulfills the need for an instrument to determine the frequency of a signal source operating in the vicinity of the new US television channels (470-890 mc). Thus, the tuning range of the local oscil-

lator of a UHF television converter could be measured and adjusted. - Another need, however, which is not satisfied by the absorption meter, is that of determining the resonant frequency of passive circuits, which are not generators of energy. Such an instrument would permit

the measurement of resonance of UHF converter preselectors, mixers, wavetraps, and oscillator or amplifier "tanks" with all power removed. This need can be fulfilled by a UHF adaption of the popular grid-dip oscillator.

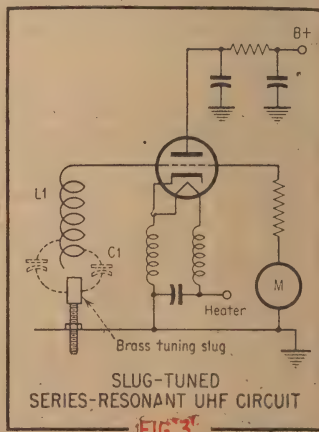
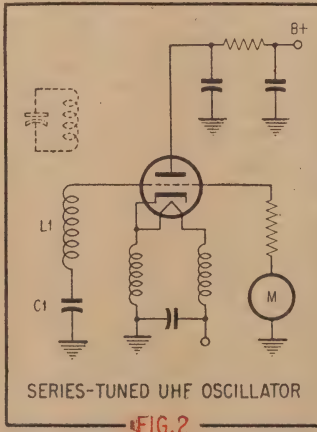
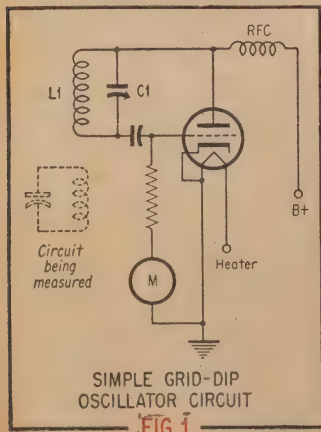
The design and construction of an experimental instrument of this kind is the subject of this article.

Anyone who has used a grid-dip meter at low frequencies is well acquainted with the versatility of the instrument. Amateurs, service technicians, and laboratory personnel have been quick to adapt it to many uses. It should be an equally valuable tool in the UHF region.

To understand the special design requirements of a UHF grid-dip meter, however, it may be well to review the operating principles of this device.

Basically, the grid-dip meter is a simple self-excited oscillator, capable of continuous tuning over the required range of frequencies and provided with a metering arrangement in the grid circuit to measure grid excitation. These conditions are met by the simple ultra-audion circuit of Fig. 1.

In this circuit the grid and plate



rent. The meter (M) reads the rectified grid current, which is a measure of the RF energy in the "tank" circuit.

Now, if the resonant circuit of an oscillator of this type is brought close to another circuit which is tuned to the same frequency, some of the RF energy in the oscillating tank circuit is absorbed. The result is a sharp decrease, or "dip" in the rectified grid current.

This happens since the removal of some of the oscillator energy reduces the amount of feed-back drive available to the grid.

The plate current undergoes an increase at the same time, due to the increased oscillator loading. The grid-dip, is sharper, however, since a cumulative effect occurs; a decrease in the RF energy in the tank, caused by absorption, results in less feed-back drive on the grid, which decreases the output and, hence reduces the grid drive still further. Therefore, a sensitive indication of resonance in a nearby circuit is provided.

If the grid-dip oscillator is calibrated in terms of frequency or wavelength, the frequency or wavelength of the circuit being measured is then known by the point at which absorption takes place.

The accuracy is maximum when the coupling between the grid-dip meter and the circuit of unknown frequency is the least which will produce a readable "dip".

Although the design of a grid-dip oscillator for low frequency usage is a relatively straightforward undertaking, producing one for use in the UHF TV channels is considerably more difficult.

"TRANSITION" AREA

This is partially so because, the new channels lie in the "transition" portion of the radio-frequency spectrum where the frequency is "too low for cavity circuits and too high for coil and condenser circuits".

It is difficult also because of the special requirements of a grid-dip oscillator which must:

- (a) Oscillate smoothly over at least the frequency range extending from 470 to 890 megacycles.
- (b) Have sufficient stability to prevent frequency "pulling" by the circuit being measured.
- (c) Have a compact form factor suitable for hand probing in limited space.
- (d) Have a resonant circuit configuration which affords easy inductive coupling to external circuits.
- (e) Be easy to construct with a minimum of machine work.

The best place to look for a type of self-excited oscillator to fulfil these requirements is among those which have been developed for UHF television local oscillators. Unfortunately, the field is limited to a few types, since many manufacturers have utilised the harmonics of oscillators operating at lower frequencies.

The UHF tuner circuits which have proven successful for fundamental frequency operations are the butterfly, the semi-butterfly, the split-ring, the series-tuned circuits, and various forms of transmission line tuned oscillators. We might well consider applicability of these kinds to the grid-dip application problem at hand.

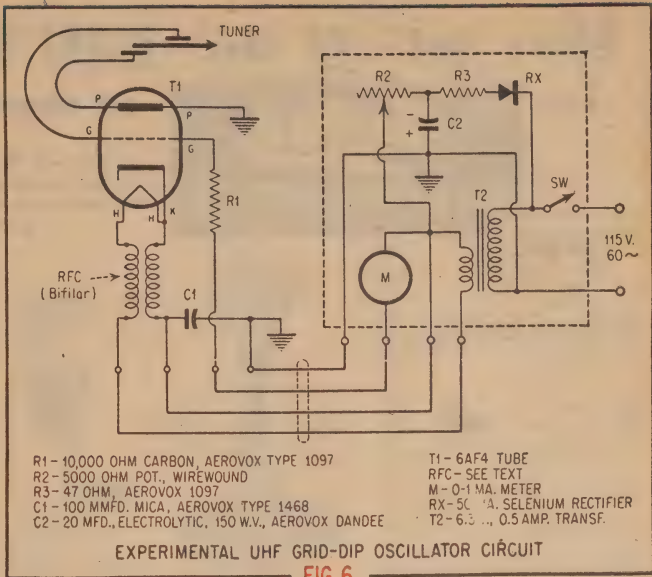


FIG. 6

The split-ring or split-cylinder tuner, now widely used in TV converters, could be used for grid-dip oscillator purposes although its form factor is not ideal in its usual form. For a hand-held oscillator it would be somewhat bulky and difficult to tune conveniently.

Experimental split-ring oscillators were tried using this kind of tuner, modified as in the absorption frequency meter described earlier.

It was hoped that the entire oscillator could be constructed within the tubular handle which forms the basis of the split-cylinder tuner. A grid-dip oscillator having an ideal form factor would result. However, it was found that the addition of the

tube interelectrode capacitance to the resonator circuit lowered the upper frequency attainable.

To compensate for this effect, a smaller diameter cylinder would have to be used, precluding the possibility of enclosing the tube and other oscillator parts within the handle.

The butterfly tuners have the dis-

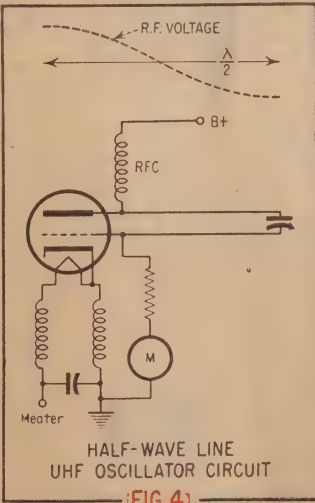
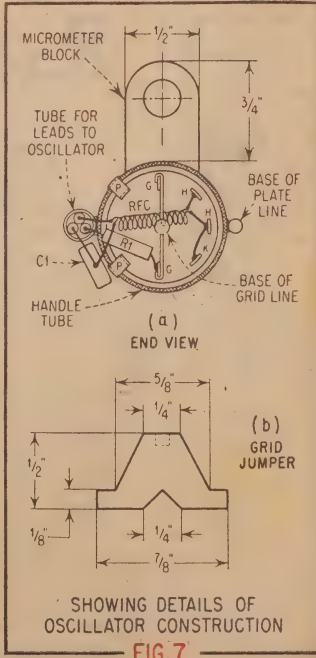


FIG. 4



SHOWING DETAILS OF OSCILLATOR CONSTRUCTION

FIG. 7

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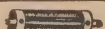
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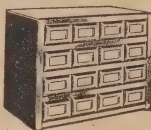
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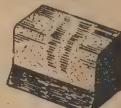


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9 x 7	3/-	14 1/2 x 8	5/-
9 x 6 1/4	3/-	15 1/2 x 8	5/6
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advantage of being difficult to construct and are somewhat bulky for this frequency range.

The semi-butterfly tuner is easier to construct than the full butterfly, but has a poor figuration for our purpose, and tunes rapidly with shaft rotation, making reading difficult.

Being a single-ended parallel resonant circuit, it is also considerably foreshortened by the tube capacitance.

Series-tuned local oscillator circuits, such as that illustrated in Fig. 2, do not easily cover the frequency range required, unless a tapped coil is used. Accurate calibration then becomes difficult to maintain.

A special form of the series-tuned oscillator is shown in Fig. 3. Here the effective length of the coil is changed during tuning by a grounded metal slug, which slides inside the coil in such a manner as to move the ground point progressively higher and so reduce the inductance.

NOT SUITABLE

Although it is being used to some extent in UHF local oscillator service, attempts to adapt it to a grid-meter were not successful, because the required tuning range could not be covered in a structure capable of easy construction.

The oscillator type finally adopted is the half-wave parallel line circuit of Fig. 4. In this arrangement, the more usual shorted quarter-wave-length is replaced by an open-circuited, half-wave-length line connected between the grid and plate of the oscillator tube.

This provides a greater length of line external to the tube than the quarter-wave circuit does, facilitating coupling to the circuit being measured.

An oscillator of this kind can be tuned by a variable capacitance located at the end of the grid-plate line. A voltage maximum point exists at this point as well as at the other end where the tube electrodes are connected. This voltage distribution is indicated in Fig. 4 as a dotted line.

The zero-voltage point moves along the line during tuning, being in the centre when the capacitance of the tuner is equal to the capacities of the tube elements and socket combined. At the high frequency end of the tuning range, the nodal point may be within the tube envelope.

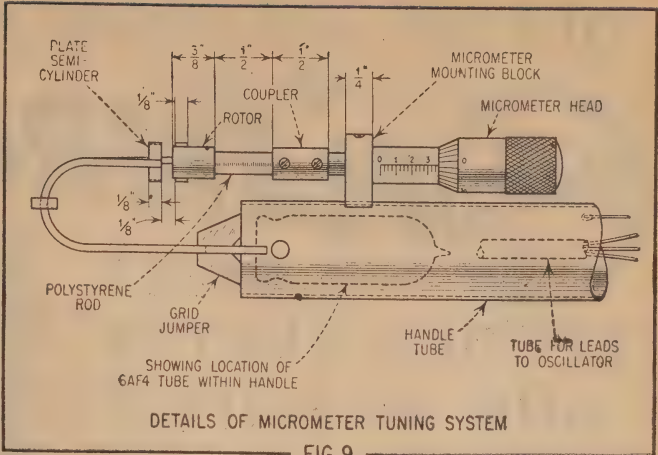
By careful design and construction, the oscillator of Fig. 4 can be made to operate smoothly over the UHF TV range. It requires so few parts that the entire range can be used as a hand probe, held and tuned by one hand.

SUPPLY UNIT

To render the line circuit more compact, the line is folded to form a "U" so that the capacitive tuner is close to the tube. The curved portion of the "U" then serves as an inductive loop to couple the grid-meter to the circuit being measured.

The tube employed is the 6AF4 miniature now popular in UHF converters. Radio frequency chokes are used in the heater-cathode leads to maintain the entire cathode structure above RF ground.

The dip-indicating meter and the power supply required for the oscil-



lator are housed in a separate unit with flexible interconnecting cable. For convenience in the construction of the oscillator, the anode is operated at DC ground potential and the cathode at negative 100 volts. For this reason, the power supply is connected for positive-grounded output.

COMPLETE UNIT

The completed experimental grid-dip oscillator and supply are shown in Fig. 5 and the corresponding electrical circuit is given in Fig. 6. It must be stated here that, because of the critical nature of UHF circuitry, satisfactory results can only be expected if the details of the oscillator construction are closely followed.

Most of the operations involved in making the unit can be performed with hand tools, although several parts should be lathe turned if possible.

The oscillator unit is built in the end of a piece of standard brass tubing 7-8 in. o.d. and 5 in. long. This tube forms the handle of the grid-dip probe. The 6AF4 oscillator tube mounts inside this tube with its

socket terminals about flush with the end.

A high quality ceramic miniature tube socket of the type having a metal shield base will fit snugly inside the brass tube if the mounting "ears" and small "nubs" are filed off. The metal detail through the centre of the socket is also removed.

To facilitate insertion and removal of the 6AF4, a 1/4 in hole is drilled through the wall of the brass tube to coincide with one of the holes in the shield base. This allows the blade of a small screwdriver to be inserted between the tube base and socket to disengage the tube for removal.

END VIEW

Fig. 7a illustrates the end view layout of the oscillator end of the brass tube, with the relative positions of the parts and terminals.

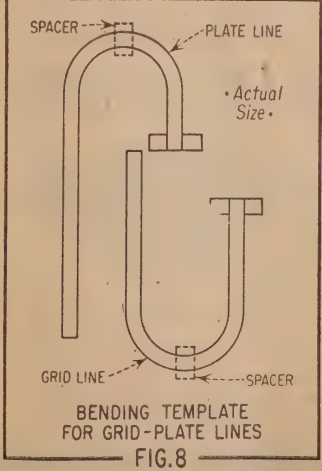
The two-plate terminals of the tube socket are soldered to the inner surface of the handle tube at the nearest points. The grid terminals are tied together by a piece of sheet copper or brass about 0.15 in thick and cut to the shape indicated in Fig. 7b. The tabs on the end are crimped around the socket terminals and soldered.

Crimping provides a firm mechanical attachment which will hold the grid jumper in place even though the solder is re-melted in subsequent soldering operations.

Since the 6AF4 and socket fill the entire diameter of the handle tube the leads to the oscillator must be run along the outside. For this purpose, a piece of 1/4 in o.d. brass or copper tubing is soldered along the length of the large tube at the location shown in Fig. 7a. A strip along the length of each tube is liberally tinned with solder before the two pieces are "sweated" together with a hot iron.

SPECIAL RF CHOKES

The construction of the RF chokes for the heater-cathode circuit of the grid-dip oscillator is critical. If the cathode lead inductance is not the



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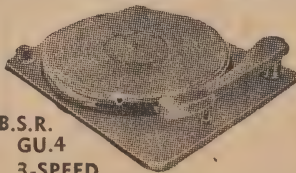
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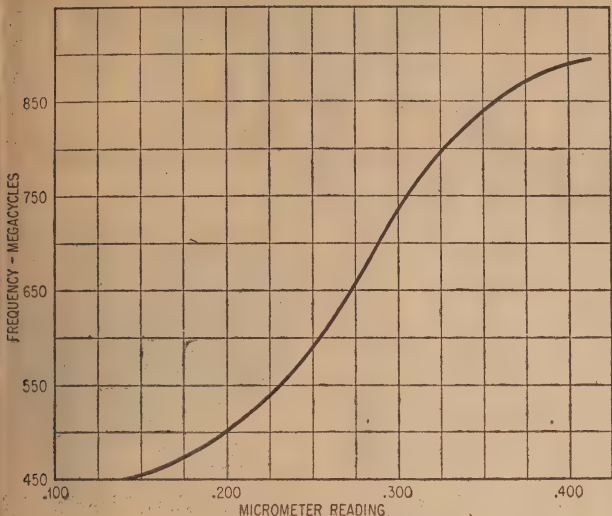
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TYPICAL OSCILLATOR CALIBRATION

FIG. 10

proper value, the oscillator will exhibit "holes" in the tuning range which make its use for determining the frequency of other circuits difficult, since the tuning "holes" also result in dips in grid current.

A satisfactory choke system is made by winding both coils simultaneously with No. 22 enamelled wire on the shank of a No. 32 twist drill (.116in).

This bifilar winding is made self-supporting after the removal of the drill by twisting the ends of the wires together for a distance of $\frac{1}{4}$ in on both ends of the required 12 close-wound double turns. The wound part of the choke is $\frac{1}{4}$ in long and mounts against the ceramic socket in the space between the two-plate terminals and between the two grid terminals.

The grid-plate line circuit is made of No. 12 B. & S. gauge tinned copper.

The plate wire is 3in long and the grid wire is 2 $\frac{1}{2}$ in long. These wires are bent to form a "U" according to the actual size template given in Fig. 8. The grid line is $\frac{1}{4}$ in longer at the tuner end of the line and the plate liner overlaps $\frac{1}{4}$ in at the tube end; $\frac{1}{4}$ in of this is soldered to the surface of the handle tube at the location indicated in Fig. 7a.

The tube end of the grid line is soldered to the centre of the sheet-metal jumper made to tie the grid terminals together. A neater connection will result if the grid wire is slotted with a small saw for about $\frac{1}{8}$ - $\frac{1}{4}$ in so that it will fit around the jumper.

A dielectric spacer is used to maintain the proper spacing between the grid-plate lines. It consists of a $\frac{1}{4}$ in x $\frac{1}{4}$ in x $\frac{1}{4}$ in polystyrene bar drilled on $\frac{1}{4}$ in centres with holes just large enough to admit the line wires (No. 38 drill).

This spacer may then be fixed firmly at the proper location indicated in Fig. 8 by liberally tinning

the wires at that point and sliding the spacer quickly into place while the solder is still molten. The spacing between the wires should be 3-8in except at the tuner end, where they spread to $\frac{1}{4}$ in.

The capacitive tuner for the grid-dip is made by soldering small semi-circular plates to the ends of the grid and plate line. The one on the plate line becomes the stator of the tuning capacitor, while the one on the grid wire acts as a wiper against the rotor.

The rotor consists of a short cylinder of brass tubing which is driven longitudinally to engage the stator sections by a micrometer head drive mounted on the handle tube. The micrometer head, which can be of the cheaper variety, provides an easily readable calibrated drive which can be manipulated smoothly with the thumb of the hand holding the meter.

TUNER DETAILS

The details of the capacitor tuner are shown in Fig. 9. Since the builder will probably have to utilise whatever micrometer head is readily available, and the exact duplication of this detail is not necessary, dimensions dependant on the drive used will be left to the builder to determine.

The micrometer head is mounted on the side of the handle tube at the angular position shown in Fig. 7. This is accomplished with a brass block, as shown in Fig. 9, which is drilled with a hole of the proper size to fit the stationary barrel of the micrometer and fitted with a set-screw to lock in place. The bottom of the block is filed to the proper contour to fit the handle tube and is "sweated" in place.

The tuner rotor, made from brass tube stock $\frac{1}{4}$ in i.d., 5-16in o.d., and 3-8in long, is pressed on to a $\frac{1}{4}$ in polystyrene shaft. This "poly" shaft, in turn, is coupled to the micrometer shaft by means of a rigid shaft

(Continued on Page 89)

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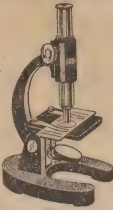
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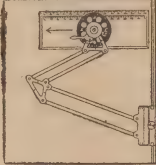
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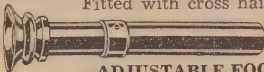
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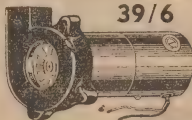
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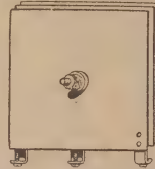


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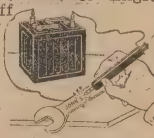
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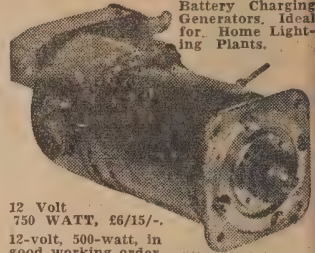
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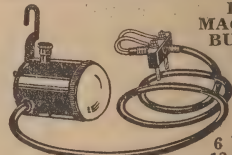


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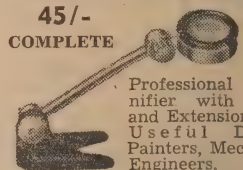


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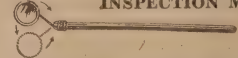


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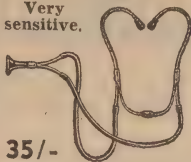
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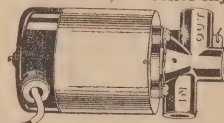


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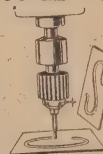
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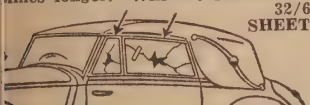
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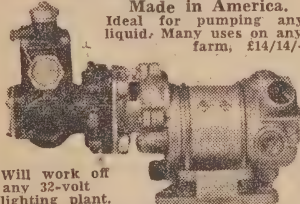
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GETTING YOUR AMATEUR LICENCE

This month we continue the series of articles on amateur radio which was interrupted by the holidays, and consider some points about aerials and aerial feed lines.

AERIALS are something of a mystery to the average newcomer to amateur radio, mainly because they are so different from other components in a radio system and because it is beyond amateur facilities to make measurements with them, unless the amateur concerned has accumulated a few clues.

If he is used to measuring resistance with an ohm-meter, for instance, he often finds it hard to believe that we can talk about resistance at the centre of a half-wave aerial as being about 72 ohms when a measurement with his meter at the end of a feedline shows an open circuit!

For this reason it is a good idea to get some facts straight right from the start, and, although an amateur may never be called upon to go deeply into the mathematics of aerial systems, he will not find it so hard to build up a mental picture of what goes on.

TUNED CIRCUITS

Most amateurs by now will realise that a circuit tuned to the frequency of his transmitter is a combination of electrical quantities, namely, inductance, capacitance and resistance.

When a coil and condenser are connected together, the coil supplies the inductive reactance, and the condenser the capacitive reactance. The resistance is contributed largely by the metal of the coil.

When the circuit is tuned to resonance, the inductive and reactive components exactly balance out, and only the resistance remains at the terminals of the circuit.

This isn't just the ohmic resistance as would be read on a meter, but the resistance to the flow of RF current in the circuit. Although its exact value becomes rather complicated to establish with accuracy, we can accept the fact that it can be quite low in a good coil.

Naturally there will be an electrical field concentrated mainly about the coil, something like the diagram in Fig. 1. The more compact the coil, the more restricted will be the lines of force which represent the field and the less likely they will be to reach other objects nearby.

RESTRICTED FIELD

It is quite a good thing to design such circuits to produce a restricted field. Any lines which escape or are sidetracked elsewhere can play only a small part in maintaining it, and represent loss of power.

Theoretically, the field around any such coil is infinite in size, but its strength dies away rapidly in most cases, and the loss from an efficient circuit is small.

That portion of the field which does extend beyond the coil sets up electrostatic and electromagnetic

waves in space, which can be detected by a receiver, for instance, tuned to the frequency concerned, and we thus have a radiation of energy.

But the proportion of such radiation to the amount of power in the tuned circuit itself, assuming we have a transmitter connected to it, will be exceedingly small and, for most amateur transmitters, will not extend to any detectable degree more than a few yards away.

We couldn't carry out much communication with it, although it might be enough to cause interference to receivers near by, as many amateurs have found!

Imagine now that we were to make up a tuning coil which, instead of having many turns of small diameter, had fewer turns of larger diameter. Let's imagine our coil was so large that it became several feet across.

Such a coil would have an electrical field very much larger than before, and it would be capable

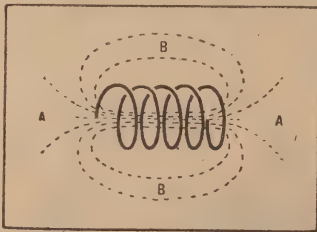


Fig. 1. The electrical field surrounding a coil in a tuned circuit is not all confined to the coil—some of it extends beyond, and by setting up waves which travel into space, allows a power to be dissipated as radiation. If the wire is straightened out to form an aerial, the maximum amount of radiation will be possible, because the field would then extend to its limit.

of creating a much larger disturbance in space through the lines of force which would describe large loops around it.

We would now be able to detect radiation over greater distances and moreover we would find that the minimum plate current of the transmitter output stage would be higher than with the smaller coil. This rise in current would have a direct relationship to the power of the waves radiated from the coil.

If we carried our mental picture to an extreme, and imagined a coil which consisted of one very large loop of wire, extending right outside the house and well up into the air as it would at say 7 Mc, this general effect would be increased.

We would now have a very large field indeed round the coil, enormously larger than the one which surrounded our original diameter of a couple of inches. Radiation from such a coil would be quite considerable and an appreciable proportion of the transmitter's power would be taken up with it.

It is not practicable to build such a huge coil, at least for the normal amateur bands, so we must use other methods of achieving radiation.

One way would be to attach a length of wire to the tank coil and hang it up in the sky. Now the electrical characteristics of a piece of wire are not essentially different from those of a coil of wire. It has capacitance and inductance proportional to its length and to a certain extent to its diameter. It has capacitance because it forms one "plate" of a capacitor, the other being earth and it has resistance because it is a piece of wire.

If it were wound up into a coil the inductance and capacitance would be called "lumped" because they are lumped together in a small space.

Up in the air, these characteristics are called "distributed" because they are distributed along the full length of the piece of wire.

RESONANT LENGTH

It is obvious, therefore, that we can find a length for our aerial which will exhibit a resonant frequency the same as that of the transmitter, and it will behave just like a strange looking tuned circuit. The main difference is that its electric field will be the largest we can possibly achieve, and if the aerial is fed with power from the transmitter it will radiate the strongest possible field into space.

If we coupled such a length of wire to the tuned circuit, it would become in fact an extension of Every aerial, whether connected to the transmitter directly or via a transmission line, is an extension and part of the transmitter tank circuit, but whereas the portion represented by the original coil and condenser cannot radiate efficiently, the aerial portion can radiate very well.

If the aerial happened to be exactly resonant at the operating frequency, the transmitter would not require retuning, but in practice this rarely happens. Aerials fed in this way are usually given some method of altering their electrical length to correct their own tuning, and are generally tapped along the coil to provide the most efficient feed point.

If they are of a length appreciably greater or smaller than required for resonance, they will alter the transmitter tuning, for they have added both inductance and capacitance to the circuit. Sometimes this can be balanced out by retuning, but there are limits.

Summing up to date, there-

Radio, TV and Hobbies, February, 1955.

fore, we have established that, as the tuning coil itself cannot radiate efficiently because of its confined electric field, we have to add to it a second circuit, preferably resonant, whose field is not so restricted, and hang it up in the form of an aerial wire. The dissipation of the aerial's electric field in space will absorb power from the transmitter, and this will be reflected by a rise in the final plate current when the aerial is properly connected.

EFFECT OF FIELD

The nature of radiation is rather difficult to visualise, but its root cause is the building up and collapsing of the electric field which surrounds the aerial at a rate equal to the frequency of the transmitter. It has two components, which are at right angles to each other: the electrostatic field and the electromagnetic field, and these travel away in all directions at 300-million metres per second like a series of ever-expanding balloons.

As they flow past and through metallic bodies, such as a receiving aerial, small voltages and currents will flow in these bodies. Because the radiated waves are alternating in character, the induced voltages and currents will also be alternating.

In the case of the receiving aerial, the intercepted power is fed down into a receiver, and after having being amplified and rectified, can work a pair of phones of a loud-speaker.

Radio waves, therefore, are really only changes in an electric field which occurs at the frequency of the transmitter, and which can produce corresponding currents to flow in objects which intercept them as they move through space.

Returning now to the aerial itself, we have seen that radiation may take place from a length of wire, resonant or otherwise, which is connected to the transmitter tank coil. But it is most inconvenient to use such aerials in many cases. Much of the radiation takes place inside the transmitter room which is the last place in which it is wanted. Its electrical characteristics are affected by uneven capacitances to ground along its length and it has other disadvantages.

It is a much better idea to string an aerial well up in the air at a selected height, and carry power from the transmitter up to it by means of a connecting or feedline. Most aerials are arranged in this way.

RF FEEDLINE

Now getting back to fundamentals, we must remember that the transmitter is a generator of power, and that the aerial is the load to which we wish to feed that power. Additionally, the feedline is required to connect the two in such a way that it wastes as little as possible in the process, and couples the generator to the load most efficiently.

The most efficient coupling of power between two electrical circuits will take place when they are both resonant, or tuned to the same frequency. The first thing to do, therefore, is to provide such an aerial, and the second to couple it into the transmitter.

The shortest length of wire which represents a resonant circuit is equal to one electrical half-wave-length of the transmitter's frequency. It is true that quarter-wave aerials are sometimes used, but in such cases a ground or simulated ground connection is added which in effect provides the missing quarter-wave. On its own, a quarter wavelength represents the maximum amount of detuning we can get.

A half-wave aerial is often called a di-pole or a Hertzian aerial, after an early radio scientist who discovered the nature of radio waves.

The reason for the half-wave-length's behavior is that it is just long enough to allow an electric charge to move from one end to the other and back again during one RF cycle. In other words it is the shortest length into which we can fit a complete rotation in phase of current and voltage, if we visualise a wave travelling from one end of the aerial to the other at the normal speed of propagation.

If a resonant half-wave aerial is suspended in free space, and a radio wave reaches it, current will flow in it, voltages will appear along it, and there will be a magnetic field set up around it just as happens to any other resonant circuit when fed with power.

Because of the alternating nature of the power being fed to the aerial this magnetic field will be building up and collapsing at the same frequency per second as the frequency of the transmitter. As a result, the distribution of voltage and current along the aerial is not stationary. Both are building up to a peak value, falling to zero, building up to peak in the opposite direction or phase, and falling once more to zero.

Consequently, when you see these pretty pictures showing the distribution of voltage and current on a half-wave aerial, remember that they are only valid for a timeless instant, and are only useful to show the state of distribution at this instant.

It is equally important to remember that the whole idea of transmission, voltage and current distribution and so on depends on the fact that the fields around the aerial are constantly building up and breaking down. It is the key to the whole basis of wave propagation, whether along an aerial wire or through space.

So that when we draw diagrams showing a high voltage point at the

end of a half-wave aerial, that doesn't mean that it is high at every instant. Like any other alternating voltage, it builds up to its peak, falls to zero, and builds up to an equal peak in the reverse phase, as we have already described.

Now, when we want to measure an AC voltage, we generally do so by recording its RMS value. You will remember this from earlier electrical theory. It is equal to .707 pc of the peak value. So when we say that the end voltage is high, we mean that its RMS value is high, and not that it can't fall to zero once each half cycle.

We emphasise this point because many amateurs imagine there is a high voltage at the aerial ends something like a DC component. There isn't—it has an AC component just as much as the 240 mains has an AC component. The only difference is that the frequency is very much higher than 50 cycles per second.

The half-wave aerial is, therefore, the standard unit in resonant aerial design. Numbers can be added together to form long wires, and they will still be resonant as

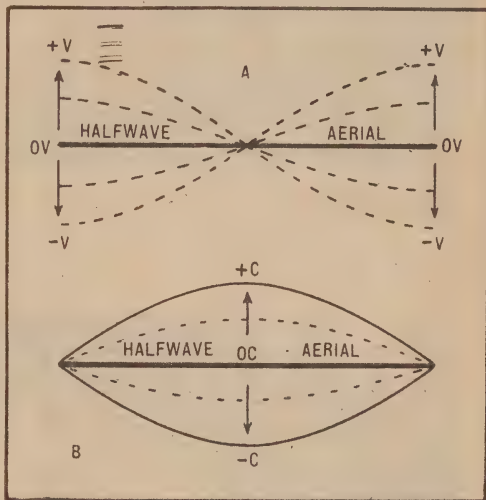


Fig. 2a. As the electrical field around the aerial builds up and collapses, the voltage at the ends of the aerial does likewise, swinging from plus V down to 0V during one quarter-cycle, and building up again to minus V on the succeeding quarter-cycle. During the next half-cycle the process is reversed. At the centre, the voltage never rises beyond a small value, but at the ends it will show an RMS value at all times.

Fig. 2b. The current rises and falls in the aerial so that its maximum value occurs at the centre and its minimum at the ends. At the centre it will show an RMS value at all times.

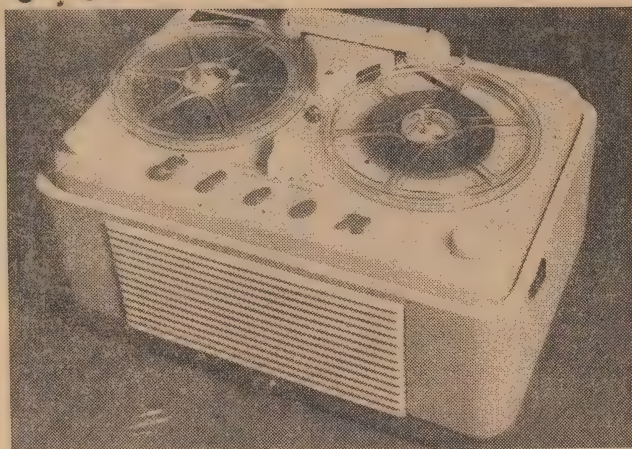
long as there is a complete number of half-waves. The maximum degree of non-resonance would be when the aerial length includes an odd quarter-wave.

All parasitic aerial arrays are based on the half-wave aerial, varied in length to give the required directional effects. The large directional curtains used in fixed ground stations are all made up of combinations of half-wave elements.

Before we can consider connecting a feed line to an aerial we want to know more about

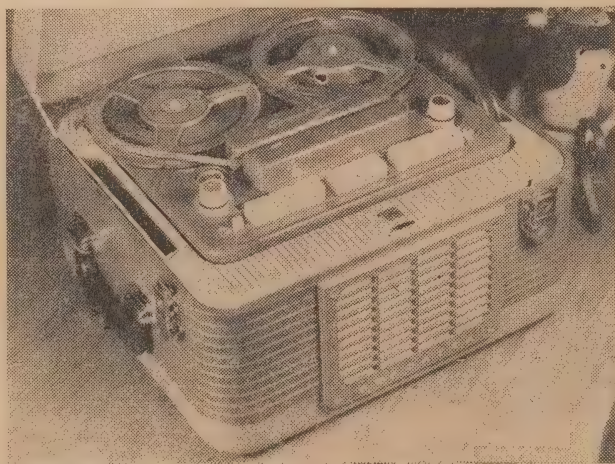
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Its electrical characteristics. These can be stated quite simply. At the end of a half-wave aerial, the RMS voltage is always at a maximum, and in the centre it is always a minimum. Conversely, the RMS current at the ends is at a minimum, and at the centre a maximum. And, lastly, the impedance of the aerial at the ends is always high and at the centre it is always low.

Note that the current maximum and minimum is always a quarter-wave away from the voltage maximum and minimum. That checks up with the fact that, in any tuned circuit voltage and current are 90 degrees out of phase. It must check up, because it takes a full wavelength for voltages and currents to complete a full reversal and come back to their original values and phase, and, of course, 90 degrees is one-quarter of the full 360 degrees, if you want to look at it that way.

QUARTER WAVE APART

Many good men have attempted to explain why these things should be so, and you will have read about them in the handbooks. Unfortunately it is only possible to give an accurate and full exposition by using a mathematical analysis of the distribution of voltage and current throughout the aerial, and that's not much use for an amateur examination.

It is necessary to accept, therefore, that if we add up algebraically the instantaneous voltages and currents at a larger number of points over the aerial, with free use of the slide rule, and much patience, we will find that for voltage the answer is always the maximum at the ends, and minimum at the centre, and for the current the maximum at the centre and minimum at the ends.

That should be good enough for the examiner, and will satisfy you more completely, for the time being at least, than an involved statement of analogies which sooner or later fall down and lead your thinking astray. It wouldn't be a bad subject for a separate article, and, after some of the staff discussions we have had about it, it might some day be possible to point the bone at a possible author!

IMPEDANCE

So far, we have considered only voltage and current along the aerial. But there is another quantity—impedance—which is the third member of the trio covered by Ohm's Law.

Now 'impedance' normally implies a resistive and a reactive component. But in a resonant circuit, the reactive components—inductive and capacitive—exactly balance out, leaving an impedance which is purely resistive.

So the first thing we learn about aerial impedance is that, provided the aerial is resonant, the impedance at any point on it is purely resistive.

This is important particularly when we come to the problem of attaching feedlines to aerials. If the circuit concerned were not resonant, as would be the case if the aerial were too long or too short, we could not fit an exact number of half-waves into its length. We would find that the phase-reversal

which occurs at the ends of the aerial was either not complete because it was too short, or had already taken place and the next half-cycle began before the end of the aerial had been reached.

Our addition and cancellation of waves along the aerial would now be upset and we would no longer have a smooth distribution of sine waveforms on our graphs. We would have a reactive component to consider, and steps would be necessary to adjust the aerial length electrically to an exact number of half-waves.

The next problem is to establish the value of the resistive component in both cases. This isn't hard to visualise if we think back to Ohm's Law. If we have a constant power input, and find a resistive point of very high voltage, we can do a rapid but simple calculation and arrive at the conclusion that the impedance there must also be high.

This is the case at each end of the aerial.

In the centre, however, we have a point of very low voltage but high current, so we rightly conclude that the impedance at that point will be low. We can't measure it with an ordinary meter, but we know it must be so by analysing and observing just what goes on.

Our mental picture here isn't completely consistent because it suggests that the distribution of power along the aerial is constant. The truth is that at any given point it is constant, and although we couldn't work out Ohm's Law sums for all the points and get the same answer in power, we would find the impedance, depending on the ratio between voltage and current which we would find there, always the same at any time.

What are the values of these impedances? They will depend on the length of the aerial, its height above ground, its proximity to other objects, and the ratio of its length to its diameter.

For a wire aerial very high in the air, about 2500 ohms appears at the ends, and about 72 ohms at the centre.

In between these points we will have intermediate values, rising to equal values for equal distances from the centre. Thus we could find two points some distance from the centre which would be 600 ohms resistive, or 1200 ohms, or any other value up to the nominal maximum or 2500 at the ends.

How would we define the resistance at these points? We can only do it by an equivalent method, and

say that it is the same value which, if connected to the end of a feedline in the form of a plain, non-inductive resistor, would absorb the same amount of transmitter power.

Thus if we were testing a transmitter fed from a 72 ohm line, and didn't want to radiate power from the aerial, we could wire a non-inductive resistor across the end of the feedline, and it would behave exactly like the aerial as far as power absorption is concerned.

This value is known as the aerial radiation resistance.

There are two main types of feeders for aerials, the tuned type and the matched impedance type.

In the case of the tuned type, the feeder and the aerial are tuned together as one unit, after the aerial and feeders have first been cut to lengths which make them as nearly resonant as is convenient for efficiency and adjustment.

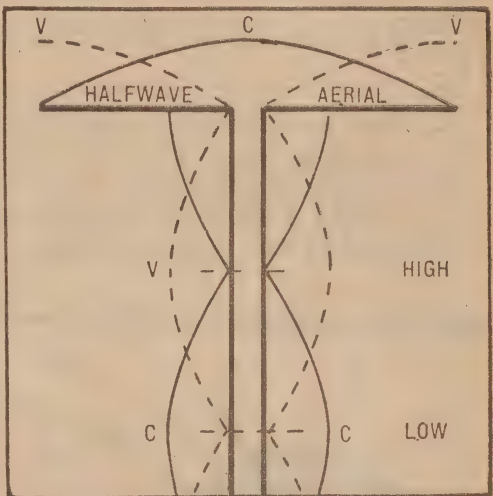


Fig. 3. This diagram shows the voltage and current distribution throughout a half-wave aerial to which a feed line is connected at the centre. The centre impedance is low, the current at that point is high and the voltage is low. One quarter-wave along the feeder the position has reversed, and there is a high impedance point. At the next quarter-wave point the impedance has changed once more to low, a process which will be repeated for further feed line extension. At the high impedance points we would use "voltage feed", and at the low impedance points "current feed".

The matched impedance type uses a feeder which is terminated at each end at a resistive point equal to its own characteristic and/or surge impedance. Such a feeder does not require tuning.

Firstly, some discussion about tuned feeders, a very popular example of which is the open wire tuned type.

Imagine we have two wires, several wavelengths long, strung out and spaced quite closely together. If we fed power into these wires, they will try to operate as aerials, and to radiate in the normal manner.

But because they will be fed from opposite ends of a coupling circuit, their voltages and currents will be equal in value but opposite in sign or phase.

As one wire tries to build up an electric field in space, the other

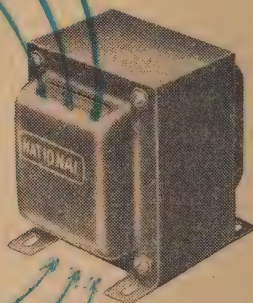
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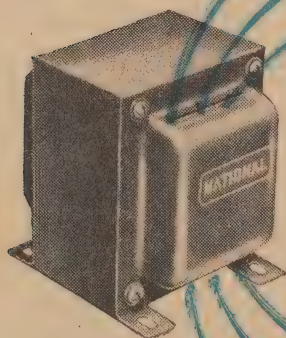
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cancel it out and no lines of force will extend very far beyond the wires themselves.

As long as there is some spacing there will not be complete cancellation, and a little radiation loss will result. But in practice it can be kept very low indeed. Now the distribution of voltage and current points along the two wires will follow the aerial pattern in that they will repeat themselves each half-wavelength along the line. The difference is that we can control the starting point by connecting either a high or a low impedance at the feed end.

ELECTING IMPEDANCES

Assume that we connected a half-wavelength of line to the centre of half-wavelength aerial, where we now the impedance is 72 ohms. The quarter-wavelength down the line we would come to a reversal of conditions, with a high impedance and a high voltage point.

At the full length of the half-wave feeder we would find a second reversal of conditions, and the same low impedance, low voltage and high current which we know is at the centre of the aerial.

As we add extra quarter-wavelengths to the feedline, we will get repetition of alternate high and low impedance points for as far as we like to go.

If instead of connecting the line to the centre of a half-wave, where there is a low impedance, we connect a half-wave to each end of the feed line, we will, of course, give a high impedance at the point of connection. A quarter-wave down the feed line things will have changed, and the impedance will be low. A quarter-wave further on, making a half-wavelength in all, the original condition will be repeated, and the impedance will again be high.

The procession of high and low impedance points will continue as before, as long as the feedline is extended.

In extreme cases, some feedlines are for many wavelengths before reaching the transmitter, with only a little radiation loss.

Such a line can be used, therefore, to transfer power from the transmitter to the aerial merely by adjusting its length to give high or low impedances at the ends, according to how we intend to feed the aerial and how we intend to couple into the transmitter.

ELECTRICAL ADJUSTMENTS

It is generally not practicable to arrange for the feedline to be exactly the right length physically, because it represents a resonant circuit with distributed inductance and capacitance, we can make adjustment electrically by tuning the line.

If it is too short, we can add inductance to the end in the form of a tuned circuit (parallel tuning), and if it is too long we can shorten electrically by using series tuning condensers (series tuning). This is often the easiest method, because it is easier to allow the feeders to provide the extra bit of inductance required for our tuning circuit, than to add it externally.

The important thing is to see that either by electrical or physical adjustment, the line is resonant, so that at either end, a resistive termination appears, whether high or low impedance.

The reason why the feedline does not absorb appreciable power from the transmitter is that it radiates so very little. When connected to the transmitter, it becomes part of the output circuit, and oscillations occur along it just as in any other tuned circuit.

The aerial absorbs power from the transmitter because it can and does radiate. The feedline merely serves to recreate at the aerial the same electrical conditions as would have appeared at the transmitter had the aerial been connected directly to it.

Because an aerial can only be cut exactly resonant for a single frequency, it is made slightly non-resonant every time an amateur works inside one of the bands, but not exactly on the frequency for which the aerial is cut.

SIMPLE ADJUSTMENT

With tuned feeders, this is not a serious matter, because the whole system can still be tuned to resonance by tuning at the feeders. The electrical junction of the aerial and feed lines will creep a little way along the aerial itself if it is too short, and a little way down along the feed line if it is too long.

It is possible to adjust for quite an amount of misadjustment in aerial length by this method, but only if the range of feeder tuning is sufficient to bring the whole system to resonance.

In the next article of this series we will carry the discussion of aerials and feedlines to include matched impedance feed and directional aerial systems.

BANDSPREAD WITH RF STAGE

(Continued from Page 35)

adjustment or no is required if the coil unit is carefully handled during the construction of the receiver.

The aerial and RF coils can be checked if necessary for maximum sensitivity, peaking the cores first at the low frequency end and the trimmers at the high frequency end.

Except for the adjustment of aerial and RF coils for maximum sensitivity very little can be done immediately about the short wave bands, since oscillators and even signal generators are seldom accurate enough for the alignment of bandspread receivers. Later, when some stations on these bands have been identified, an attempt may be made to bring the pointer to the exact operating frequency of these stations by adjusting the respective oscillator coils.

CLOSE TO MARK

However, it will normally be found, that the coil unit is aligned sufficiently accurately for most purposes, as allowances have been made for stray capacitances with the unit wired into a receiver.

That's the way it worked in our case anyway. After only a rough check, the receiver was duly taken home over the weekend and put

BIGGER, BETTER COLOR TV

(Continued from Page 11)

face. We have also used a rim coil in the form of a loop placed near the plane of the phosphor plate, in addition to the magnetic shield.

"Our new 'Color Equaliser' performs the function of the rim coil, but, unlike the rim coil, its effects may be controlled at various points around the circumference of the color tube face. It makes unnecessary either a magnetic shield or the rim coil. The net result is a better, more positive effect, and a reduction in cost of the receiver.

"The magnetic shield has been an item of relatively high cost in a color receiver. We now propose to use the new RCA "Color Equaliser" in place of the magnetic shield and the rim coil formerly used.

"By doing so a saving will be effected in the cost of manufacturing our new 21-inch color receiver. In indicating this saving we are comparing the use of the lowest cost magnetic shield we have been able to develop for our 19-inch glass envelope color tube together with a rim coil, and the Color Equaliser for use with our 21-inch metal envelope color tube.

"The saving on this item alone represents a saving to the consumer of at least 20 dollars."

Color programs should begin to make their presence felt in 1955. The NBC alone will start the year with about 80 inter-connected stations and, in all, about 87 per cent of TV families in the US will be in range of Color programs.

through its paces. It certainly lived up to our expectations.

With a very simple aerial (a few yards of hookup wire strung from a pole in the yard) good daylight reception of many country and interstate broadcast stations was achieved. No difficulty was experienced in receiving stations from Western Australia and Tasmania from about 7 pm onward. During the night, when most Australian broadcasting stations had closed down, several SE Asian stations could be received.

GOOD SELECTIVITY

Selectivity on all bands was excellent.

The tuning on the short wave bands presented no difficulty and stations could be tuned in with the same ease as on the broadcast band. Even with a short aerial shortwave reception was well above average. With a good aerial these results could no doubt be bettered. For instance, the double doublet aerial as described in our November, 1948, issue should do a lot toward improved results. It also has the added advantage of combating man-made interference, which can seriously handicap a receiver with high sensitivity.

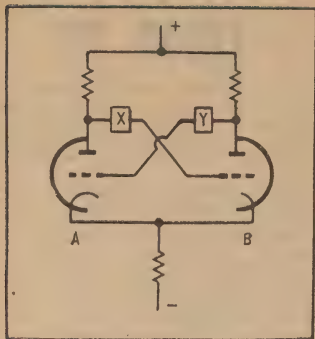


FIG. 1. The Flip Flop Circuit.

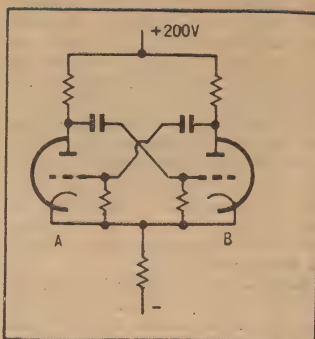


FIG. 2. The Multivibrator Circuit.

be used in an electronic computer by arranging that a valve conducting represents 1 and non-conducting represents 0. There are no intermediate states or levels and the state is completely unambiguous. The Flip Flop circuit is used to achieve the ON/OFF state without which a computer could not exist.

Enough, however, of generalities and down to the details of this most interesting circuit, which is shown in figure 1.

It will be seen that it consists of a triode A, having a given amplification, coupled to the grid of an identical triode B, which has the same amplification as A. The anode of this valve is coupled to the grid of the first triode.

The cathodes of both these valves are connected via a common resistor to earth, but this point may be ignored for the moment.

The "boxes" "X" and "Y"

MEET THE VERSATILE FLIP-FLOP

Curious but expressive is the term "Flip-Flop", which appears so frequently nowadays in radio and electronic literature. What does it mean? What kind of a circuit does it describe? This article gives you the answer.

By J. R. FIDDYMENT, A.M. Brit., IRE.

IN practically every application of electronics there is used a simple circuit built around a double triode valve, so arranged that only one-half of the double triode can possibly be conducting at a time, the other half being completely cut off.

The fact that one half is conducting is the reason for the complete cut off of the other, and if something should happen to cause the latter to conduct, then the former would immediately be cut off. There is virtually no intermediate state where both are conducting. The general name for such a circuit is a "Flip Flop," although strictly speaking this name should only apply to one specific arrangement of the circuit.

This provides that the circuit will normally remain stable with one valve non-conducting until an external triggering pulse is applied to its grid. The circuit will then reverse its condition and remain thus until the other grid is triggered, whereupon it will resume its original condition.

With wider applications of electronic circuitry the Flip Flop family has grown to a considerable size, capable of exceptionally high performance. Although, to achieve such a performance, the basic circuits have been elaborated, nevertheless, shorn of the "trimmings", the circuit is still a Flip Flop in one of its three basic forms.

In passing, it may be noted that the binary method of counting can

the coupling elements between anodes and grids, and it is a selection of the components for coupling that determines the mode of operation of the circuit.

For a start, both components may be considered to be capacitors. This then means that the grids will have no DC return to cathode, which the valve makers tell us is bad practice, so a resistor is connected between each grid and cathode. The circuit is now as figure 2 and called a "Multivibrator" circuit.

As may be imagined, when two valves each having amplification are coupled back to each other in this manner, the result is a highly unstable combination.

The circuit, however, still has two states, with valve A cut

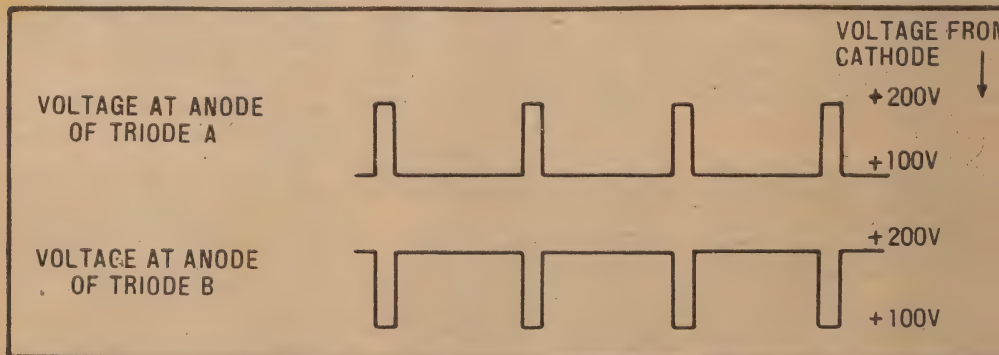


FIG. 4. Voltages observed at anodes of circuit of fig. 2. Asymmetrical operation.

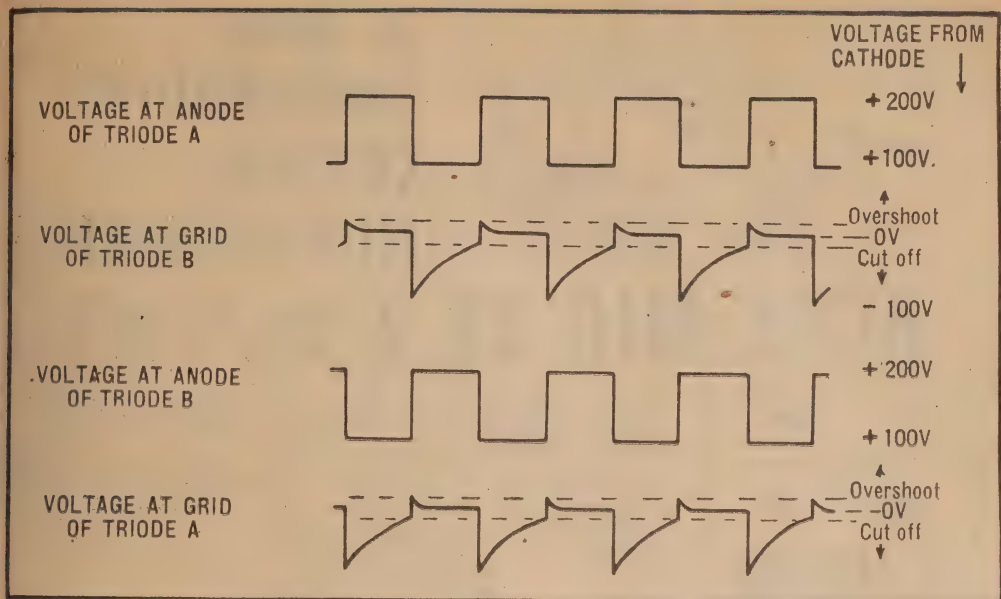


FIG. 3. Voltages observed at points on circuit of fig. 2. Symmetrical operation.

and with valve B cut off so the characteristic property of a Multivibrator is that it has "two unstable states".

In order to explain the operation of this circuit, it is assumed that triode A is fully conducting, and that triode B is cut off and it is furthermore assumed that the anode of A is at plus 100V and that the anode of triode B is at plus 200V. (This is the voltage of the HT supply, there being no IR drop in the anode load.)

If now something or other causes the grid of B to rise a minute fraction of a volt above cut-off voltage, then current will flow through B, causing the anode voltage of B to fall by an amount determined by the amplification of the stage.

FED TO GRID

This voltage drop will be fed to the grid of triode A via the coupling capacitor, and will reduce its anode current so causing its anode voltage to rise. This rise in voltage is fed to the grid of B so causing a substantial rise of grid voltage. This substantial rise in grid voltage is further amplified by B and the resulting negative voltage is applied to the grid of A to take it far below cut off.

It is appropriate to bring in a few figures to emphasise this mechanism and, by way of example, a gain of 20 per triode is assumed.

If a "disturbance" takes the voltage at the grid of B 0.001 volt above cut off then, by the time this disturbance passes around the circuit and returns to this point it will have an amplitude of $0.001 \times 20 \times 20$ or 0.4V.

A second time around would mean, if other factors did not intervene, that a voltage of 160V would appear and this when it reached the grid

of A again would be 3200 volts negative!

Such figures, of course, could not occur in practice but they serve to demonstrate the following:—

(a) That as virtually no time delay occurs between a change of voltage at the grid and the corresponding change at the anode, the change of state of the circuit is catastrophic, i.e., it happens in nearly zero time.

(b) As soon as the slightest current begins to flow in the cut-off valve the state of the circuit is reversed.

TYPICAL FIGURES

The detail of the actual change-over having been explained, the mechanism of the circuit as a whole should now be considered.

For a starting point, the instant of change-over is taken so that the anode of A is at 200 volts, as the valve is cut off and the anode of B is at 100 volts.

The anode of B has dropped during the change-over from 200 volts to 100 volts, or, to state it in a different way, a negative step of 100 volts amplitude has been generated at the anode. This step is passed through the coupling capacitor to the grid which is driven 100 volts negative to the cathode.

Due, however, to the resistor between the grid and cathode the coupling capacitor will be slowly discharged and the voltage at the grid will rise until it is equal to the cathode voltage.

Before equality is reached, however, the grid will attain a point which will allow the valve to conduct. As soon as this occurs the circuit changes over and then the same sequence is applied to the other valve.

This spontaneous reversal of the circuit will continue as long as supplies are connected to it and, if a cathode ray oscillograph were to be connected to either anode, a string of rectangular blocks indicating abrupt voltage change would be observed.

By reason of its regular and continuous output this circuit may be considered an oscillator and is often called a "Relaxation Oscillator".

WAVEFORMS

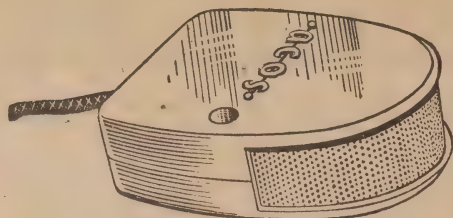
The waveforms which may be observed by use of an oscillograph at the various points around the circuit are shown in figure 3.

The graph of grid voltage shows the negative voltage step from the opposite anode and the curve as the voltage of the grid approaches the cathode voltage. The small positive "pip" which occurs when the valve changes from non-conducting to conducting is due to the positive voltage step from the opposite anode.

Since the grid of the valve acts as an anode, the positive voltage does not rise above 1.2 volts and this voltage will leak away through the grid resistor.

The length of time for which each valve remains cut off is determined by the values of the capacitor and the resistor connected to the grid of the valve. These values can be varied over an extremely wide range and the time for each half of the complete circuit is independent of the other half.

It is, therefore, possible to produce either a symmetrical output or an asymmetrical output where the duration of each of the pulses of one polarity is many times the duration of each of the other as is shown in figure 4.



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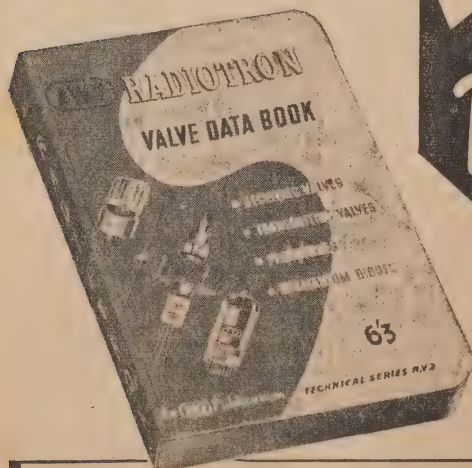
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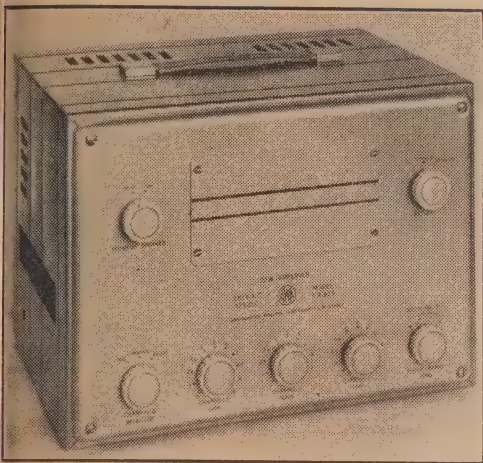
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TRADE REVIEWS AND RELEASES



UNIVERSAL PA AMPLIFIERS FROM AWA

AWA announce two new portable public address amplifiers which should satisfy most moderate public address requirements. Both amplifiers are made as a single unit and are suitable for use from either the mains or an accumulator.

THE smaller unit, the PA828 (not illustrated) has a power output of five watts and may be operated from either the mains, 200-230, 230-260 volts, 50 cps, or from a six-volt accumulator. A standby switch enables the HT to be switched off during idle periods, thus conserving battery power.

Two inputs are provided, one microphone and one pickup. The microphone input has an impedance of 5 megohm and a sensitivity of approximately 2mV. The pickup input has a sensitivity of 35 volts at 1000 cps. A bass boost of approximately 10 db at 50 cps is available in the pickup circuit, but may be disconnected if not required.

Output taps allow from one to four 600 ohm speakers to be correctly matched to the amplifier. Three controls are fitted, Microphone, Pickup Volume, and Pickup Tone.

The PA829 (illustrated) is a larger unit, having a power output of 20 watts. The power supply is either the mains or a 12-volt accumulator and this model is also fitted with a battery saving standby switch.

BSR RECORD CHANGER

THE B.S.R., New Monarch Automatic Record Changer advertised in the January issue of Radio and Hobbies is priced at £19/10/0. Further details from Goldring Engineering (Australasia) Pty. Ltd.

Radio, TV, and Hobbies, February, 1955



The larger of the two new P.A. amplifiers produced by AWA. This model, the PA829, is capable of 20 watts output. The two upper controls are the monitor speaker "ON-OFF" and the battery switch, including a standby position. The lower row contains a channel selector, three channel gain controls, and a tone control.



BOOK REVIEW

VALVES FOR A.F. AMPLIFIERS. By E. Rodenhuis. Price 12/6 approx.

This book, as its name implies, is intended solely for readers whose interest lies in audio reproduction. It approaches the subject largely from the valve designer's point of view.

However, it must not be supposed that it is little more than a discussion on suitable valve types, it being a very effective treatise on the entire subject of audio amplifiers. It commences with the essentially practical subject of layout and finishes with equally practical data on the construction of eight amplifiers, varying in power from three watts to 100 watts.

In between is a wealth of useful data and practical hints, and the publishers claim that it is intended to wean the enthusiast from the stage of blindly following published data to a point where he can intelligently select, and even evolve designs most suited to his purpose.

There is a chapter devoted to the general types of valves required for various stages, together with discussions of the stages themselves and their problems.

Next there is a chapter devoted to technical data on European valves suitable for audio work, followed by hints of the practical use of such data. There is a chapter on components and circuits, including some interesting speaker response graphs, and this is followed by the constructional data for eight amplifiers.

Altogether, this book should prove a useful addition to any audio enthusiast's library, and at a very reasonable cost.

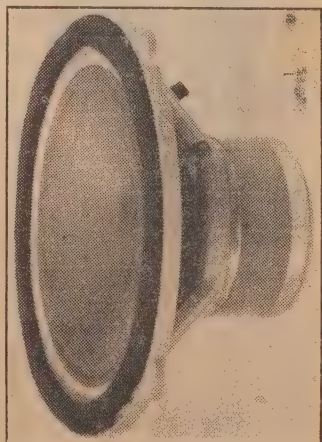
NEW 9-INCH SPEAKER FROM BAKER

Simon Gray have sent us an attractive 9-inch speaker for review which on test gave a particularly smooth performance.

A SMALL speaker of this type is not expected to produce a bass output comparable with much larger types, but we can expect freedom from peaks and clean output in the middle and upper registers. Mounted in a vented enclosure about 5½ square feet, the Baker provided some very pleasant listening.

Its large magnet structure has given it very good efficiency, and its low resonance freely suspended cone avoids any impression of undue humps in the bass. Well loaded, this speaker should give a good account of itself well down the bottom register.

Its output in the extreme top end is enough to give excellent definition and realism to speech and music, and the impression of smoothness was characteristic of its verall performance.



The new speaker. Note the large magnet.

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(Continued from Page 75)

coupler. The coupler must fit well enough to make the rotor run true when the micrometer drive is revolved. If the micrometer shaft used is not of the proper diameter to fit a standard coupler, one should be lathe turned.

The stationary tuner plates are made from 3-8in o.d. brass tube stock sawed lengthwise to form semi-cylinders 1-8in long. These are soldered to the ends of the grid-plate lines concentrically so that the rotor cylinder will move smoothly through them. The semi-cylinders are 1-8in apart.

SOLDERED TOGETHER

They can be best aligned by soldering them in place while the rotor is engaged, providing all parts are pre-tinned to prevent the heat of soldering from softening the polystyrene shaft.

After the plates are soldered in place, the spacing of the line is adjusted so that the grid plate makes a smooth wiping contact on the rotor, while the semi-cylinder on the plate-line is carefully spaced only a few thousandths of an inch from the rotor cylinder. This adjustment is critical if the full UHF TV range is to be spanned.

Air insulation is used between the stator and rotor if the latter has no "wobble" so that close spacing can be maintained without shorting. If not, a thin sheet of a high quality dielectric should be cemented to the inside surface of the plate cylinder. A piece of "pliofilm" of the kind used by grocers for vegetable bags was found to have sufficiently low losses for this purpose. Cellophane was found excessively lossy.

The length of the polystyrene rod is adjusted to allow the rotor to be moved from a position where its end is flush with the far side of the grid wiper cylinder (high frequency end of tuning range), to a position where it is fully engaged with both cylinders and its end is flush with the far side of the plate cylinder (low frequency position).

CALIBRATION

If good alignment and close tuner spacing is maintained, the resulting tuning characteristics will be similar to Fig. 10. The finished meter should be calibrated against a frequency standard such as a Lecher line.

The absorption frequency meter mentioned earlier is an ideal tool for use in adjusting the tuning range of the grid-dip oscillator. After adjustment, the oscillator must be handled carefully to prevent disturbing the calibration.

The use of the experimental grid-dip meter is identical to that of the low frequency versions. The plate voltage on the 6AF4 tube is adjusted (R2) until the grid meter indicates that the tube is oscillating and drawing between $\frac{1}{4}$ and $\frac{3}{4}$ milliamperes grid current. (The corresponding plate current must not exceed 16 milliamperes.)

The bent portion of the grid-plate is then brought close to the circuit of unknown frequency and the micrometer tuner is run through its

DETECTORS --- AND HOW THEY WORK

(Continued from Page 69)

only in terms of current flow and the effect of the rectifier upon it. Where the rectifier circuit works directly into the reproducer, such as a pair of headphones in a crystal set circuit, this is all we need to consider, since the reproducer is a current operated device.

In a more conventional radio, however, the output of the detector will be fed to the grid circuit of an audio amplifier valve and the changes in current flow will have to be converted to changes in voltage, the grid circuit of a valve being sensitive only to voltage changes.

This is where the diode load comes into the picture. The rectified current produced by the detector must flow through the diode load.

Now, by simple reference to Ohm's law, we know that the flow of current through a resistor results in a voltage being developed across that resistor. Thus, the diode load performs the function of converting the changes in rectified current into changes in voltage which may be applied to the following stage.

In practice, the cathode end of the diode load is connected to chassis (at least as far as the signals are concerned), so that this end of the resistor is automatically connected to the cathode of the following stage. It only remains then to connect the other end of the diode load to the grid circuit of the following stage and our audio circuit is complete.

Sometimes this connection may range. There will be a sharp dip in grid current at the frequency of the circuit being measured. A little practice with a resonant circuit of known frequency will acquaint the user with the position for optimum coupling.

Needless to say, the grid-dip oscillator can also be used for a calibrating test oscillator, a rough "Q" meter, and many of the other uses which have been found for the versatile grid-dip oscillator at lower frequencies.

be a direct one, the steady voltage developed by the unmodulated carrier being used to bias the following grid. This is known as "diode biasing", but is seldom used nowadays. The more usual method is to provide the following stage with its own biasing circuit and grid resistor, the audio signals being coupled to it through a suitable value of capacitance.

Another common practice is to make the diode load in the form of a potentiometer, thus allowing any required value of audio voltage to be picked off and providing a convenient system of volume control.

From here we would normally go on to discuss the finer points of diode detection; causes of distortion in detectors, &c., as well as the other types of valve detectors. But our quota of space has been filled and, in any case, this is enough to digest at one sitting. If it can be followed completely, the reader will have established a good groundwork on which to base further studies.



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RECORD NEWS FROM ABROAD

By DISCOBOLUS

The audio industry may fairly safely be divided into two categories—those who make the records, and the others who manufacture the equipment to play them.

IF you trace the growth of the record activity in both these fields since the introduction of micro-groove, you will find that very rarely does a famous record company intrude into the market for play-back gear. The notable exception is EMI, but they have restricted themselves to the radiogram-complete-with-cabinet style which does not appeal to the high fidelity customers. In reverse, Pye of England, always associated with good quality record-playing equipment as well as everything else in electronics, now owns the NIXA company.

IN AMERICA

In America, the same sort of thing is true. As long as amplifiers are called upon to play someone else's records, the amplifier manufacturer can always blame the records if the result is not acceptable. The same, presumably, is true of the record seller. It does come as a welcome sign, therefore, that at least one maker of first-class equipment has at last ventured into the record business.

The amplifier is made by McIntosh, of New York, and their products have always been as highly regarded there as have the Leak or Quad items in England and elsewhere.

Now, McIntosh have announced their first release of microgrooves. Whether they are doing their own recording or not, I do not know. But I am reasonably certain that the discs themselves will have been made for use on good equipment. This feature is something greatly to be desired. Musically, I am not so sure. The artists are all American and unknown to me. The music they play is well enough known, but the interpretations must stand alongside others from artists known the world over if they are to remain in the catalogues, and already many LP's have been deleted, especially from Columbia and Capitol.

NEW RECORDS

On once again to new records, this month all from America.

About the time RCA brought out their tapes, rumors spread about that numerous other record concerns were interested in similar projects. As far as I know, nothing has come of them, except for a new tape from a tape manufacturer who is selling a "duplicate" of the 1812 Overture released on Westminster and played by the London Symphony Orchestra under Scherchen.

Tape speed is evidently 7½ in/sec, but I have no further details and only mention the item in case it is a pointer to future intentions. It is quite logical, I suppose, for tape manufacturers to feed the tape past a recording head at the same time as they slit it from the large sheets just prior to packaging, and we may

see some tieups in the industry to do precisely that.

Those of you who admire the playing of Pablo Casals will undoubtedly have heard some of the recordings released on the Philips label of performances at the various festivals at Prades and Perpignan. The 1950 recordings were not acclaimed for their technical qualities, but since then, things have been on the up and up. The Schubert E Flat Trio, for instance, is a masterpiece of playing and recording.

CONCERTO BY CASALS

Now comes the news—via American Columbia and ultimately from Philips—that Casals has recorded his first concerto in fifteen years, the Schumann A Minor 'Cello Concerto. Together with Rudolph Serkin, he has also made available all the Beethoven Sonatas for 'Cello and Piano, and another disc has arrived featuring the two of them in variations on arias from Mozart's Magic Flute.

From Columbia, also, an album containing the four Brahms Sym-

phonies, played by the Philharmonic Symphony Orchestra of New York, conducted by Bruno Walter. The four discs also feature seven other works by Brahms, so that each symphony commences with the beginning of a fresh side of the disc. Oh, yes, and 'your purchase entitles you to a free 10in LP record of Dr. Walter at rehearsal', says the advert. Ever since LP began, RCA and Columbia have been offering the public "free" LP's, or 45's, or record-cleaners and the like. Only a few weeks ago RCA publicised a new issue of jazz LP's by offering anyone who likes to write in, a "jazz sampler", a 45 containing excerpts from the new LP's.

BARGAIN OFFER

And the "societies", a peculiarly American feature of the record scene, fall over each other with introductory offers. The prize goes, I think, to the Musical Masterpieces Society (related to NIXA) for their latest offer of eight new LP's for one dollar the lot—Schubert's Unfinished, Brahms' Academic Festival Overture, and works by Mozart, Bach, Dukas, Wagner, Beethoven and Moussorgsky. These discs normally sell for a dollar and a half in USA, each, of course, not for eight of them.

American Decca have substantial lists just to hand, which will appear later, no doubt, in England and perhaps here, with original recordings by Deutsche Grammophon of Brahms' Violin Concerto (David Oistrakh), Verdi's Requiem with Fricasay, Mozart Clarinet Concerto and Trio by Reginald Kell, and Lieder sung by Irmgard Seefried.

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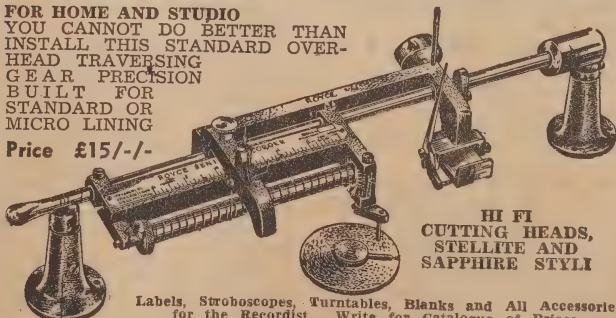
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OFF THE RECORD — NEWS & REVIEWS

We have become so used to the organ as a mighty instrument that most of us have forgotten it was ever anything else. But in the days when most of the important organ music was written, the mammoths of power such as we have in every big city did not exist.

INTERESTED people can work up a very nice discussion about whether Bach and Buxtehude are heard properly on a modern organ. Many claim that they prejudice the music's inner clarity without which the full effects of counterpoint and registration are lost.

Actually there is more to it than this, for an organ is only part of the story. The other part is the hall in which it is installed. An organ is really no larger than the stops which are used, but as most big organs are in big halls, the dispersal and reverberation of the sound are vastly different than if the hall were smaller and of different shape.

HALL ACOUSTICS

Maybe we should blame poor hall acoustics for much of the trouble.

However, if we are interested in the authenticity of early organ music, then we are likely to come closer to the mark by using a small organ of the type which abound on the Continent, and which are often comparable with those used in Bach's day.

Even Albert Schweitzer, whose musical integrity is a byword, prefers to play such music on the smaller organs rather than the big ones.

The point is well made among the program notes accompanying three excellent discs issued by Radiola, discs which cannot fail to appeal to every lover of organ music, and particularly to those who study its construction and period.

ORGAN MUSIC FROM SWEELINCK TO HINDEMITH — (Sweelinck, Byrd, Purcell, Hanff, Boehm, Michælsen, Buxtehude, Walther and Bach). Played by Fritz Heitmann. Radiola-Telefunken LSK 7010-7011.

CHRISTMAS ORGAN MUSIC — (Boehm, Walther, Buxtehude and Bach), played by Fritz Heitmann. Radiola-Telefunken LSK 7016.

As is readily apparent, the field covered by such an impressive list is far too large to be treated in detail, nor is it really necessary, for you will probably be more interested to know whether such acceptable fare is well enough presented to be worth the money.

I have no doubt of this.

The microphone is obviously mounted very close to the organ, and there is virtually no chamber echo or "cathedral" effect.

Therefore, the registration is heard with almost startling clarity, and from it we can gauge that the organ certainly wasn't made in recent times. It wouldn't be fair to use the word "wheezy" even though once or twice we might be unkind enough to find a little justification for it.

By JOHN MOYLE

But you will be impressed by the competence of the organist, and quite frequently by the sheer beauty of the tones he produces. There are no huge pipes to be heard, but if the records are played at good volume on a good machine, there is no lack of body or dignity.

MUSICAL CONTENT

I could not separate these records on any grounds, so you will have to select them for their content. A good deal of the music will be familiar only to organists, although several pieces will be well enough known to most music lovers. The "Christmas" recital isn't a topical description, so don't imagine that, like the traditional carols, you will only want to hear it on December 25.

All the discs are fairly heavily cut, with the faintest of groove echoes audible here and there. Surface noise is very low.

These are quite important records and music lovers for whom they are intended will value them highly. They play best on EMI or NAB curves.

DVORAK—Symphony No. 5 in E Minor Opus 95 (From the New World) played by the Vienna Symphony Orchestra conducted by Jascha Horenstein. Festival-Vox CFR12-309.

This record appears to have been recorded with a fairly close microphone technique in a hall with reverberation having a somewhat long time constant.

As a result individual instruments come through clearly and with good definition—something this symphony needs to bring out its many intimate moments. The strings have a vivid bite, the brass a good body and presence, the woodwind perhaps best of all.

HEAVY PASSAGES

But when the weight is on there is sometimes a curious orchestral division as the echo bounces with a delayed action effect. This muddies the sound in comparison for instance with many Westminster recordings of the same group.

The forwardness of the strings tends to give them a slight edge. Maybe it's the result of being electronically sited too closely to us as compared with the basses and tympani, and it needs some taming as a result.

Otherwise I see signs of better work than Vox has given us in the past, although I would not put it in the top class to which after all few can aspire.

Musically it has much to recommend it. It is handled sympathetically and thoughtfully, rounded into

a satisfying and always interesting whole, with no sentimental exploitation. The orchestra plays well, it always does, and its performance supplies good competition for another version of the moment.

I found an NAB setting best with perhaps a notch of top cut on wide range jobs. The surface is quite good with a few light crackles.

BRAHMS—Symphony No. 2 in D Major Opus 73. Played by the Vienna Philharmonic Orchestra conducted by Carl Schuricht. Decca LXT2859.

The main virtue of this record is that it is much better recorded than any other which comes to mind. I have always liked the Toscanini version released a few years ago, but this disc reflects the passage of time in its extra clarity and power.

CONSISTENT QUALITY

A comparison between the two during the last half of the first movement, for instance, shows the Toscanini disc losing definition, becoming dull, and dropping impact and level. This new Decca, without being a supreme example of the record making art, maintains all these things extremely well, and leaves us with the full brass untouched by the pulling any technical punches.

Musically it is a hustle job. Right from the start we are left in no doubt that this conductor, like many a famous bowler (since cricket and music are fashionably coupled the days) believes in a strategic change of pace.

Consequently he replaces Toscanini's rock-like tempo with rather freely wielded baton which if a little overdone, I did not find objectionable. I like to hear Brahms played firmly and with vigor as the moment demands, and this is one way of doing it.

In all other respects the disc up to Decca standard and played through without difficulty. A nice performance to have around.

BRUCKNER—Symphony No. 7 in E Major. CESAR FRANCK—Psyche, Symphonic Poem. Played by the Concertgebouw Symphony Orchestra of Amsterdam conducted by Eduard van Beinum. Decca LXT 2829-30.

It is very hard not to agree with the popular view of Bruckner a writer of broad and lofty music touched with dignity and greatness but at the same time a man of musical anticlimax, mixing the sublime with the commonplace, choking the heart of his work with irrelevancies and interminable extensions of unrelated sound.

But listening to this symphony one of his best known and most worthwhile, it is not hard to find

under his spell if you have the relaxation of mind and the time to spare. After all, we wouldn't have much music in our libraries if we rejected anyone because they can be banal, or verbose, or pompous or trivial. There are many composers who must be given up as hopeless before we can learn to love them.

The performance is admirable. The conductor has shaped the music firmly around its frame, his handling of the many climaxes is impressive, he and his orchestra are equally convincing whether dramatic or tender.

Clarity suffers a little in some heavily cut places, but the brass has fine weight and tone, and its part is a vital one.

A grand and successful recording. It sounds smoothest on an AES setting. The surface, although not perfect, is good.

The beautiful Franck Symphonic poem makes a fine fourth side, and its selection is a happy one.

JOHANN STRAUSS—Graduation Ball ballet by Lichine, arranged by Dorati. Played by the New Symphony Orchestra conducted by Anatole Fistoulari. Decca LXTA 2848.

The brightest possible ballet music by Strauss, much of the music unpublished elsewhere. Many will remember that this ballet was given its premiere in Sydney, 1940, and it has achieved great success overseas since that time.

The ballet story is extremely simple. The ball is held at a young ladies' academy in Vienna and is attended by young gentlemen from a nearby military college. The romance of the evening affects even the comely headmistress and the old general, but everyone has a fine time and all proprieties are observed.

The performance is full of life and sparkle and the recording likewise. First class music and first class entertainment.

MAHLER—Symphony No. 8, performed by the Rotterdam Symphony Orchestra, the Rotterdam Philharmonic Choir and soloists, conducted by Eduard Flipse. Philips A00226L-7L.

This is possibly the largest and most ambitious symphonic work ever written, if we can call a work symphonic in which three choirs outnumber the orchestra by about ten to one.

It is called the "symphony of a thousand" because that's the number of performers required, taken at a round figure.

Naturally, it is not often heard, and I doubt whether there is another performance in existence, certainly not released here on LP records.

It is conceived as a symphony of humanity, of man's praise to God, his plea for Redemption, his certainty of Resurrection.

In order to handle this theme in a manner he considered adequate, Mahler uses an orchestra of nearly 200, a mixed double choir, a boy's choir, eight soloists and an organ.

This small army was assembled at Rotterdam on July 3 last year, and gave a performance in a vast hall before an audience of 8500 people, after a couple of rehearsals at which another 15,000 were present. The city had to organise it-

self for the event and as the recording was made during the performance they even chased the sparrows out of the place so they wouldn't interrupt.

The music isn't at all difficult to assimilate—but its size makes the task one which must be undertaken with some study, and preferably a score to guide one through the maze of choral, orchestral and vocal sound. No one can do more than get a roughed-in outline after one or two hearings.

There is some parallel with this work and Beethoven's Ninth Symphony, but many essential differences.

Beethoven used voices to supplement and climax a primarily orchestral work—Mahler uses them from the start as an integral part of the whole.

It is symphonic in character, even in form, but it also has something of oratorio about it, except that there is a single flame which is kindled at the start and burns until the last. This is Mahler's passionately-felt outburst on behalf of humanity, and there is no doubt about its force. It burns as sincerely and as intensely as Beethoven's, but there comparison ends. Mahler was incapable of crystallising his thought as Beethoven was—he must give all that is in him, to the uttermost.

RECORDING SUCCESS

Considering the difficulties of handling such a recording project, I think Philips have succeeded admirably. It is quite remarkable that so much has been heard with such good balance, remembering that recording was an incidental matter to the actual performance. Only with a score could we say what we have missed, if anything, but I must say that it sounds homogeneous and convincing. There is no impression of making the best of it, but rather of planned achievement.

It has flaws, of course, but these are made up for by large sections of quite thrilling sound. Despite the huge area to be covered there are no washouts, nor is the bass anaemic, nor do the choirs scream.

It left me with a sensation of genuine musical impact, and I'm sure you will feel the same.

I found the NAB setting best. The surface, as is customary with Philips, is of the highest quality.

A word for the excellent album with descriptive notes and words in Latin and German. Unfortunately they don't help much at first, and a serious listener will find a score his only reliable guide.

BEETHOVEN—Sonata in C Minor, Opus 13 (Pathétique). Sonata in E Major, Opus 109. Played by Solomon. HMV ALP-1062.

A competent performance with, to me, at any rate, all the failings of Solomon as a Beethoven exponent which, however, may not be faults in your eyes.

He strives as always for resonant, singing tone, and in so doing tends to use his pedal rather freely at the expense of outline and inner clarity.

I have a recording of this sonata I made when Gieseking was giving concerts here, and particularly in the Opus 109, the differences on the



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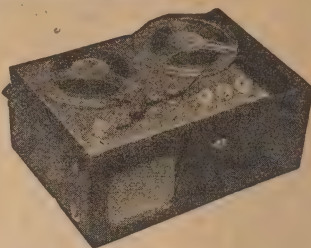
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lines I have indicated lift his version into another sphere.

If you accept the Solomon approach, then you will admit he is most successful, and I'm sure you will like this disc.

The recording is lightly cut, and the piano tone is rather lacking in crispness, although not in weight.

The Pathétique I thought the most successful, and here Solomon's reading is more robust, more in keeping with the classic conception of the sonata.

The surface noise is quite low, although it may be more evident than with a heavier recording.

MAHLER—Song of the Earth. Played by the Vienna Symphony Orchestra, conducted by Otto Klemperer, with Elsa Cavelti (mezzo-soprano), and Anton Dermota (tenor). Festival-Vox CF812-508.

I am afraid this record, despite its better features, succeeds more in suggesting what might have been than through any achievement of its own.

Its main fault is its lack of cohesion—it just doesn't blend together.

The orchestra has its moments of essential definition, but it seems to be playing more for the benefit of the auditorium, whereas the singers as far as the listener is concerned seem to be yards away in the foreground.

The tenor is by far the best—he has an air of conviction which eludes the mezzo-soprano, who sounds as though she is merely reading from the score.

In the last movement, for instance, where she is called upon for an extremely sensitive performance, she allows her part to die through what seems to be complete lack of understanding, so that the extremely beautiful closing phrases are thrown away.

This should have been a fine record, one which would serve to introduce many to possibly Mahler's most beautiful work, but I'm afraid it doesn't do that.

It is vastly improved by playing on an EMI curve with as much bass boost as you can manage. As such it must serve until we have another recording for comparison.

MOZART—Quartet No. 14 in G major KV387—Quartet No. 15 in D Minor KV421. Played by the Budapest String Quartet. Philips AO1125L.

In the Library of Congress, Washington, DC, there is a set of Stradivarius instruments, among the finest in existence, which are never allowed to leave the premises in case of damage. Anyone allowed to play them must do so at the Library.

The Budapest Quartet used this set when making this record, and that is why the recording was done there. You can pick the nature of the reverberation from the start if you are quick, and the effect is similar to that of a small concert hall.

The quality of the instruments is lovely to hear. They suit the Budapest, which has never produced sharp playing. It is the most classical of the quartets, and personally I think its style is well suited to these two works, which are from the set dedicated to Haydn.

There is a tendency among

modern Quartets to rattle off Mozart as though brightness must be achieved at all costs. But in these works there is more than just that—they have a touch that could well have been that of Beethoven. If the Budapest sees them that way, I am content to listen. Its musicianship is never at fault, and if I quarrel with their handling of an odd bar, that doesn't lessen my enjoyment of their performance.

Technically the strings are not as forward as some of Westminster's, for example, but they blend beautifully, and because the surface of my copy was so silent, all you will hear is exquisite music from a background of almost complete quiet.

High marks for this record. You can buy with safety.

TCHAIKOWSKY—Romeo and Juliet Fantasy Overture: WAGNER—Siegfried Idyll. Played by the Philharmonia Orchestra conducted by Guido Cantelli. HMV OA-LP1086.

It is likely that this record will become a best-seller before very long, for it has all the requirements.

On the one side is an electrifying performance of the Romeo and Juliet overture, filled to the brim with those things that makes Tchaikovsky a firm favorite particularly with lovers of music of the less obviously classical type. Its program of love and hate and clashing swords is easy to follow, and with what intensity are they heard on this disc! Cantelli is one of the best in this exciting stuff, but despite the abandon he gets from the music, he keeps a tight rein against noise on the one hand and mere drooling on the other.

The Siegfried Idyll was written as a serenade for Cosima, who bore him a son, Siegfried, and it was played by a distinguished group of musicians outside her window at dawn. It is based on many themes from the Ring and includes for appropriate measure an old German cradle song.

Its quiet and rapturous mood is far removed from the tension of the overture, but in its way it is every bit as successful.

The Philharmonia maintains a consistent recording balance these days, and you will, I am sure, admire how clearly the parts stand out, the fine tone of the brass choir, and the freedom from oppression during the heavily recorded climaxes.

Add to these things an inaudible surface and you have a disc in the first class.

MOZART—Concerto in C major for flute and harp. Played by Willy Glass, flute, Rose Stein, harp, and the South German Chamber Orchestra of Stuttgart, conducted by Rolf Reinhardt. Radiola-Telefunken LB6050.

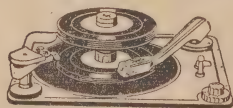
Mozart's versatility is shown by the large variety of instrumental combinations he used, and some of his most attractive music was written for them. And, although the scope of his efforts may not have been large as we see it today, he was generally successful in all of them.

This concerto can be numbered one of these works. It was written, as so many of them were, for

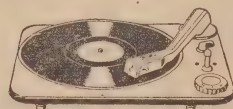


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friends, a pupil, the Duc de Guines, and his daughter, the former a flautist, the latter a harpist.

The recording is a very pleasant effort, with a quiet surface, and no difficulties in the playing. It did give me the impression, however, that something more could have been made of it. The harp is a difficult instrument to record convincingly, particularly with another having such a leading tone as a flute, so that it may not be surprising to hear it wash out on more than one occasion.

There is also a lack of brightness about the performance—the conductor's care not to hustle the harpist into an impossible speed makes the net result rather careful at the expense of spontaneity. Neither frequency nor dynamic range is very wide.

Still, it is a pleasant record and engagingly easy to take.

MORTON GOULD — Latin-American Symphonette. **SAMUEL BARBER**—Overture, "The School for Scandal", Adagio for Strings from Quartet No. 11, Essay for Orchestra No. 1, Opus 12. Played by the Eastman-Rochester Symphony Orchestra, conducted by Howard Hanson. Mercury MG40002.

This disc bears the unmistakable signature of the Mercury technique which has brought forth a number of outstanding records. It has a brilliance which is quite colossal, particularly if you take the manufacturer's advice and turn up the gain.

Only then will you get the full force of the precision playing, and the outstanding balance and clarity of the orchestral balance.

This latter is perhaps the most striking thing about this record. On a crescendo, the sound just goes on and on with no sign or breaking—it maintains a clear edge which you could cut with a knife, and a bass register, exploited by a few bass drum beats, which produces nothing less than thunder.

But although it's a record to make the sound man enthusiastic, to say the least, musically it will be a winner for most people. Both composers are among America's most brilliant. Morton Gould is particularly effective in his use of South American and Negro rhythms, and the manner in which the microphone has caught the lightest touch of instrument effects is a lesson in the art.

Samuel Barber's contributions are in more serious vein, and represent some of his best-known work. The Adagio is particularly well done.

A fine disc, this. I'll give it five stars.

MOUSSORGSKY—Pictures at an Exhibition. Played by Alexander Uninsky, pianist. Philips NO0652R.

A fine piece of piano recording. After having heard so many orchestral versions of the work it comes almost as a shock to hear it again in its original form, and to note the difficulty the pianist has at times to match the aura of color with which Ravel invested it.

And yet Uninsky for the most part does an excellent job. The second side I thought the best. At times, particularly in the first, there seem-

ed a tendency to fade here and there—to round off a corner with an unsure dynamic judgment, to miss the little edge which would have kept the outlines sharp. There is an impression of heavy weather in some places, but this may be accentuated by the forward placement of the microphone.

A good amplifier will revel in the weight and sonority of the bass register which is so well done in the recording. That big chord which dramatically introduces the Catacombs, for instance, really made me jump as it was intended to do. And in the final stages, the whole keyboard rings out in a first-rate piece of disc work.

The surface noise hasn't a hope of getting through the music, there are no bobbles or clicks, and every note is clean. The EMI setting I found the best.

BARTOK — Violin Concerto played by Yehudi Menuhin and the Philharmonia Orchestra, conducted by Wilhelm Furtwangler. HMV OALP1121.

If your staple diet has been Mozart and Beethoven, you will wonder what this concerto is all about. At least, on first hearing.

The second or third time you will become suddenly aware that the whole thing is conceived on a completely different plan. You will begin to recognise shape where before existed only bewildering chaos. You will begin to accept orchestral effects, which at first hearing made no sense at all. You will see the concerto assume outline and balance on a broad scale.

Then you will suddenly see a world within it which you did not suspect. And your entire musical outlook will be changed.

To say more than this would require columns of type, and at the end you could only gain the impression which I give now, that this is an important and beautiful concerto, which, far from being a clever example of modernism of little value, will I am sure take its place among the major works for the violin, as it has already done overseas. It is a superb example of imagination and competence, and it will reward you for the time spent in getting to know it.

MENUHIN'S AUTHORITY

The performance is perhaps the best thing about it. Menuhin achieves an authority from the first bar which demonstrates that he at least understands and respects the work, both for its music and for the opportunity it gives for him to exhibit his stature as a violinist which, after hearing this record, no one could doubt.

It is not only brilliant — it has most moving passages of great beauty, it has color of exquisite sensitivity, it is filled with modulations which will interest and delight you. And, strangely enough, it has bars and bars of sheer melody.

I haven't another recording for comparison, but I doubt whether any other could head this one in the important matters—orchestral balance, clean violin tone (far from the anaemic stuff we've sometimes heard from Menuhin), good pressing and quiet surface. The orches-

tral color uses instruments so freely that some of them are sure to sound a little backward at times, but these are details.

I rate this record very highly, and thoroughly recommend it to serious collectors of a representative library.



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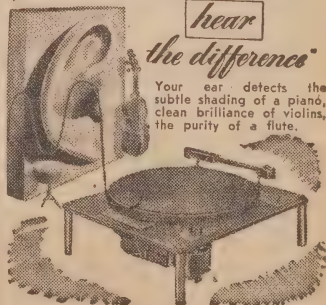
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AS opposed to the fairly flexible message handling routine used during emergency operation in most countries, the special committee set up by the Radio Society of Great Britain to organise their RAEN (Radio Amateur Emergency Net), have laid down a very complete set of rules for operation along service communication lines. They cover fully all phases of operation likely to be encountered during any emergency.

From experience gained here with varying propagation conditions, the various channels amateur to amateur or commercial station in use and the fact that specific amateur stations were not always available for operation, no concrete set of rules for emergency working was set down. Even the decision as to whom was to act as control was left in abeyance until the net swung into operation.

DIFFERENT CONDITIONS

There is, however, one major difference between working in emergencies here and in the UK. Many more stations are available for net operation in any given area over there while the distances points covered should be smaller. Perhaps definite nets covering specific areas would be practical.

The rules as drawn up by the committee have to be the subject of comment in the correspondence section of the RSGB Bulletin, but salient points would interest CDCN and Emergency Net operators. The normal control station in each net is the ECO or his deputy, and all orders issued by these officers must be promptly obeyed.

The normal emergency calling frequencies are 1900, 3600, 7050, 14100, 21150, 28200 kcs. and 145 mcs.

These frequencies will only be used by control officers to get his net into operation, which will then be set up on another frequency.

A complete set of typical message forms are listed and methods of procedure set down.

Under some circumstances messages can be handled between outer stations and not via control, but reports to the latter must still be made.

A priority classification has been arranged—URGENT (URG), covering police and Red Cross messages; Service (SVC), relating to the working of net; and Unclassified (UNC), messages of lesser importance. Every message should have a priority prefix as listed above.

If a message cannot be delivered, the originator must be notified.

Full lists of Q signals, abbreviations, R/T procedure and special Q signals for RAEN are listed.

The whole system is quite complete and extensive practice sessions will be needed to ensure that all operators are conversant with the procedure as laid down.

It is emphasised that the primary duty of the net is in an emergency and will be to send back information to the nearest available centre possessing post office telephone facilities.

The service must not usurp the functions of the Post Office or other government communication system.

COMMERCIAL STATIONS

Up to a few months ago the number of commercial stations operating in the exclusively amateur section of the 14 mc band was restricted to a few code stations including our friend FOD—at least that was all that were heard here. Judging from the times they are audible they would be located in the Far East.

However, during more recent months there has been a general invasion of the band.

Interference from commercial stations on the section 14000 to 14100 Kc/s is now

nearly as heavy as experienced in the sector 7000 to 7100 kc/s. During one evening recently nine commercial signals were heard in the first 100 kc/s, including some broad S9 carriers. At times the first 30 kc/s was inoperable. The latest addition is a Chinese station sending press in English—good code practice—but its usefulness ends there.

Judging from overseas comment especially in Europe it would appear that we cannot be too optimistic on the moving of these stations from amateur bands, there even seems to be the possibility of an increase in interference.

The British GPO makes some interesting points in an official statement to the Radio Society of Great Britain, which was published in the RSGB Bulletin.

The text mainly concerns broadcast stations operating in amateur bands but is applicable to code stations—the latter causing the interference on the 14 mc band.

G.P.O. STATEMENT

The GPO's statement ran as follows:—"The orderly use of the radio frequency spectrum which can be used for long-range communication is governed by international agreement, and must, therefore, depend ultimately upon mutual goodwill between nations.

"The pre-war international agreement on this subject was necessarily largely outdated by the rapid development in the use of wireless during the war, and a new allocation was drawn up after the war. Most stations are now engaged in a gradual transfer of their services into the frequency bands appropriate to them under the post-war table.

The speed with which this transfer will be accomplished will depend not only on international goodwill, but also on the ability of all countries concerned to find suitable replacement frequencies for displaced services. The great increase in international broadcasting which has come about since the war has necessitated the use of many more frequencies for external broadcasting services than would otherwise be required.

"A number of countries are having, for the present, to operate their broadcasting services in non-broadcasting bands. This has greatly hindered the process of transferring all broadcasting stations to their appropriate frequency bands. Moreover, the fact that the major powers, including the UK, have themselves not so far been able to accomplish this desirable end (although, as far as the UK is concerned, no broadcasting station now operates in a band exclusively allocated to amateurs under the post-war allocation table) limits the power of persuasion which can be brought to bear on other nations who are operating broadcast stations outside their bands.

"The UK Government is doing all it can to encourage the moving of broadcasting stations into their correct frequency bands, but expects the situation to remain difficult while the external broadcasting requirements continue at their present levels.

The final paragraph gives some indication of the problem and while nations still desire to disseminate publicity and propaganda there appears to be no solution for the removal of "intruders" in exclusive amateur bands.

DX CONTEST

The 21st ARRL International DX contest will be conducted during February and March.

Two different sections will be run, Telephony and CW, and each will extend over two weekends. The Telephony section commences at 2400 hours GMT on February 11 and closes at 2400 hours GMT on February 13. The section opens

again at 2400 hours GMT on March 11 and concludes at 2400 hours GMT on March 13. The CW section will be run between similar times on February 25 to February 27 and again on March 25 to March 27.

Serial numbers must be exchanged comprising the signal report plus the approximate power input in use—579050 for 50 watts input, 579350 for 350 watts input for CW, or 57050 and 57350 for Telephony contacts.

Two points are scored on receiving acknowledgment of a number sent, and one point upon receiving a number.

The total number of points scored above are then multiplied by the sum of the number of W (K) and VE/VO licensing areas worked on one band plus the number on one band plus the number of licensing areas worked on each other band.

The same station may be worked for additional points on different frequency bands.

A certificate will be awarded to the highest scoring amateur in each country, and W/VE call areas.

Logs and a summary of operation should be forwarded to the ARRL 38 La Salle Rd., West Hartford, Connecticut, and must be mailed not later than April 30.

I.A.R.U. CONSTITUTION

The Executive of the Region 1 Division of the International Amateur Radio Union covering Europe and portion of Africa have drawn up a constitution covering their future activity. They will work for the general interest of all IARU societies in the world and the constitution of the International Telecommunication Conferences.

The Division will hold at least every three years a conference of all National Societies in the region.

They will elect, by vote of the member societies present, an International Executive Committee comprising a chairman, vice chairman, secretary and at least two other members. The committee shall have full executive power between conferences. The routine affairs of the Division shall be undertaken by a secretariat and expenses incurred covered by levies on member societies. The Honorary Secretary is responsible for this routine work and he shall keep in close liaison with IARU Headquarters at the ARRL.

This extension of amateur activity at international level especially on the Continent should do much to assist the hobby in the smaller countries. Closer contact between societies should also ensure the most effective representation at ITU conferences, where the future widths of our bands are decided.

V.H.F. NOTES

Propagation conditions fell off badly on the 50 mc after the opening week of the Ross Hull Memorial Trophy contest. For the next two weeks openings were rare despite the fact that many stations were active.

During the Xmas-New Year period two really excellent openings occurred however.

Generally it was considered the band was not as good as during last year's contest and that Sporadic "E" is assisted by the sunspots.

The accepted first appearance dates for VK6's, ZL's &c., did not hold good this year causing some consternation. VR2CG was still supplying the DX interest with VK9's assisting. Early in January VK4NG's contacts tallied nearly 400 so perhaps he would consider conditions quite good.

It is hoped that longer openings will occur during this month.

The journey to Mt. Kosciuszko for 144 Mc "Operation Rooftop" by Roy Hart, VK2HO and Pere Healy, VK2APQ, was not without incident. They arrived on Friday afternoon and set up camp and their equipment and made some test transmissions during the evening. Opening at 10.30 am on January 8, VK2APQ transmitted until 11.30 am with wind velocity increasing all the time. It was found

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6H6 double diode (noise limiter)	7/6
6J5 triode	12/6
6J7 pentode	12/6
6K7 remote control pentode	12/6
6L7 Heptode (frequency converter)	12/6
6SH7 sharp cut off pentode	7/6
6SK7 remote control pentode	12/6
6SL7 double triode	12/6
6SN7 double triode	12/6
6U7G remote control pentode	7/11
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954 UHF sharp cut off pentode	10/-
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110. The Emperor Radio-Gram for home constructors.
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Transmitter — 30 to 50 megacycles
Constant volume amplifier control unit.
Receiver — 30 to 50 megacycles.
Power Supply — 24 volt.
(Can be converted to other voltages)

This Set uses fourteen valves, line-up as follows:— 3-807 in Transmitter; 2-807 in Modulator; 3-698 and 1-6J7 in Amplifier; 2-6U7; 1-6J7 in Amplifier; 2-6U7; 1-6J5; 1-6G8; 1-6V6 in Receiver.

Has two Meters, externally mounted over the door. Audio Zero Level Power Level Meter 6 milliwatt, graduated in + and — descibels, and Transmitter Meter F.S.D. 1 milliamp double reading, graduated 0 to 100 mil. and 4 to 5 mil. Also two Indicator Warning Bezels for Transmitter and Receiver.

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necessary by then to abandon the tests of the two of them could not hold the over 3 over 3 array which was blown down and smashed.

A fairly rapid descent from the peak was also indicated and the gear was stashed up and the site evacuated.

Roy and Perc after contacting VK2ARD then journey back to VK2BQ at Tumut to warn them that the tests were cancelled and also repair their beam. A great deal of work and planning had been performed to ensure the equipment was working satisfactorily, it was regrettable the the b-z-z-z arrived at the critical time.

On the Sunday the gear was set up at Kendall near Tumut.

Some very successful contacts were made with VK3CI, VK2RS, Albany, and VK5 2PN, 2BQ and 2ZAA, of Tumut. VK2AJQ of Coolamon was also heard as was VK2ANF over the 200 mile path to Sydney. This was some compensation for work and 750 mile trip entailed. Stations throughout NSW, Victoria and South Australia were standing by for contacts and it is hoped the trip can be repeated under better conditions so that all can have the opportunity of contacting VK2HO/P from the "Blue Top".

In NSW the field developed into an unofficial field day.

Stations were located in elevated positions up to 180 miles from Sydney. Excellent contacts up to nearly 200 miles were made. Parties included VK2ATO at Harrington Tops, VK2HL near Gosford, VK2YM and VK2JW at the Blue Mountains, VK2MA and VK2WJ were operating from the Blue Mountains. To add a little more interest VK2ABO was Mobile Marine in and out of Sydney Harbor.

Many other stations were active from their home QTH's in the Sydney and from country areas.

REALLY MOBILE

G2RO during his Empire wanderings has been creating interest on 14 mc from various Pacific prefixes. Bob is perhaps the best known of the Portable DX fraternity and his African jaunt of last year caused a furore on the band.

Early in January he was signing VRIRO and will be active from Cocos Islands (Indian Ocean) in February, travelling here via VK. He will sign ZC2RO from the island.

His original timetable as published has been varied considerably.

Bob's QSL-ing record is excellent and number of new countries will be chalked up by many stations. If you are missing a QSL for a G2RO prefix contact, a repeat QSL card sent via the RSGB and marked to check should ensure the receipt of the desired QSL.

Bob uses only a 15 watt transmitter and does excellent work for such power. G2KU-VS5KU who has been active from Brunel hopes to travel to Sarawak and operate for one month, he will sign VS4KU from there. G2KU will QSL all contacts on his return to England. Cards should also be sent via the RSGB.

ZD6BX Nyasaland provided a surprise by appearing at 1730 hours EAST around 4050 kc/s.

He contacted a number of VK's and Z's and have worked more if he had not been requested to listen out for stations by amateurs with whom he was in contact. While it is a nice gesture to ensure that one's friends make the elusive QSL, one must think of the repercussions in the many other stations patiently standing by, hoping to add to their countries list.

Probably they have been waiting hours and it is not fair to put other stations ahead of them. Patience and plenty of time are essential for DX working on these days, and to avoid ill feeling and rises in blood-pressure operating procedure should assist those many stations on the frequency.

Some of the world's leading DX exponents are experts at the interpose even when they can only hear one end of the contact.

They transmit with their KW's hoping that some one will give them information on the frequency &c. of the DX station.

DX working is getting tougher every day but there is one thing certain in the event of a "Dog-pile," you either give up the chase or adopt similar tactics to those in the hunt if you are to be successful.

Radio, TV and Hobbies, February, 1955

Once the rare station signs VA it seems to be the cue for all and sundry to man the key or mike.

It is a pity we all cannot wait until both stations have signed. At some stage or other we all break accepted rules—probably unintentionally—but we can endeavor to keep up the frequency of the DX station, call at the right time &c, and retire rather than react if the choice prefix is blotted out by the multitude.

It seems a possibility that Russian Radio Amateurs are again allowed to contact stations beyond the "Iron Curtain." A number have been heard calling CQ as opposed to their "WSEEM" general call. Perhaps the privilege is only granted to specific stations, but a number contacted D1's and DJ stations.

W.I.A. XMAS PARTY

The Xmas Party of the NSW Division of the WIA was held during December.

Special emphasis was placed on entertainment for the ladies and varied items were presented.

The presentation of a silver coffee set was made to the NSW State President, Jim Corbin, VK2YC, and his wife, in recognition of the services rendered the Division through the years.

George Wilson VK2AGO was responsible for the general organisation.



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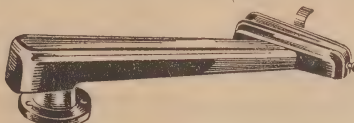


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["OFF THE RECORD" Review by Mr. John Moyle —
Radio and Hobbies, December, 1954, Page 90.]

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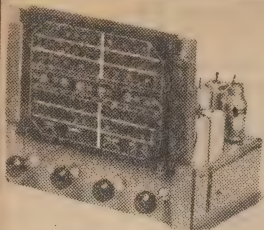
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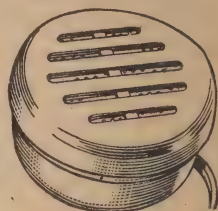
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IT'S A REAL MINIATURE
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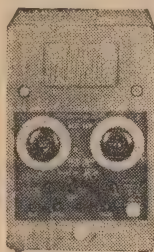
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Postage: NSW, 5/-; Interstate, 7/6.

39/6

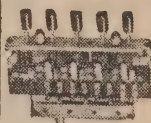
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Input filter supplied with genemotors

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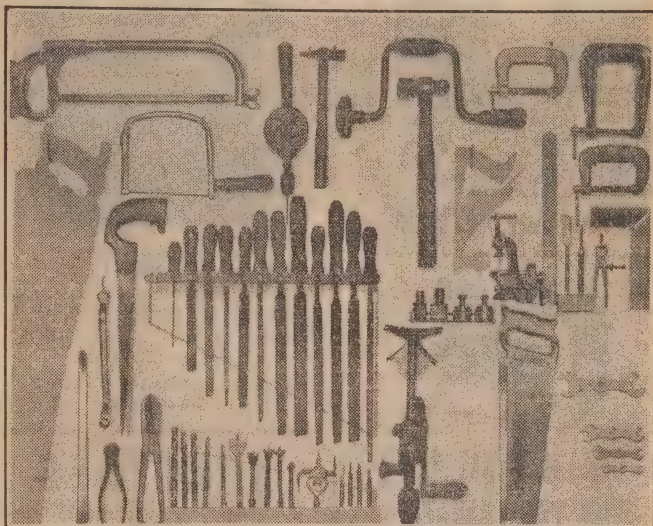
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MAKE YOURSELF A SHADOW BOARD

How many times have you spent several minutes looking for a tool that is hidden beneath a pile of odds and ends. Multiply those few minutes by the number of times it happens and it is easy to justify the expenditure of a few hours to solve the problem once and for all.



A typical shadow board. Note that the saw and plane are missing.

IN the normal course of events, the average handyman collects quite a few tools of trade. Almost certainly he will have a modest carpenter's kit and probably the various hand tools which are familiar to radiomen.

Maintenance on the family car will add a few more, as will any other special interest.

For those who have to work on the kitchen table, about the only solution is a transportable tool box. These can be bought in all shapes and sizes from hardware stores and you can choose according to your purse.

However, for those who have a more or less permanent space to devote to workshop activities, a tool box is not the best answer.

Even with a well-arranged box, the tools are inevitably two or three layers deep and, to get to those on the bottom, you have to disturb the top layer. In the process, the keen edges get knocked off, the smaller ones get lost under the larger, and some are lost altogether.

BETTER SCHEME

The same objections apply to workbench drawers and to a lesser extent to upright cabinets.

A far better solution is to mount the tools on a board where they are all visible.

You are able to see the particular implement you require, and the job of tidying up after a job is made very much easier when everything has a proper place.

The size of the board is a matter for the individual. Some may prefer to fit everything on the one large board as was done in the example shown in the photograph. Others may prefer to have a number of smaller boards, each devoted to tools of a particular type.

Whichever method you choose, the important thing is to realise that extra tools will inevitably need to be added from time to time and due allowance should be made for it.

You may have two files now, but you'll end up with at least half a dozen. Allow enough space for the extra ones to hang.

However, there is no need to be a slave to this policy. Even if a particular tool has later to be mounted out of its logical position, it will not matter a great deal. The main point is to have it accessible—as it will always be on a shadow board beside your work bench.

Heavy plywood is undoubtedly the most convenient timber to use for a shadow-board preferably half-inch or thicker. Alternatively, quite a

commendable job can be done with solid stock from packing cases, planed and fitted together.

It would obviously be difficult to attach the tools with the board screwed to the wall, and you will find it convenient to have it horizontal while doing this part of the work. At the same time you can mark the outlines in pencil in preparation for filling in the shadows in some color contrasting with the rest of the board.

When it comes to hanging the tools, with the board fixed to the wall, a selection of medium and large brass cup hooks will solve most of the problems.

DOCTORING

Bend the cup hooks to the appropriate shapes and screw them in where they will support the tools in the positions already decided upon.

Some tools will require support brackets, which can generally be made up from metal scraps. On the board pictured above, the files hang by their wooden handles from a bracket with slots cut into it, rather like a coarse comb.

Also available are commercially made tool clips in various sizes suitable for a hammer handle or a midget screwdriver. Their use will simplify the construction considerably.

The large drills and centre-bits, &c., stand in a wooden block in which large holes are drilled.

If the board occupies a fair proportion of the wall space there is a good argument for painting it the same color as the rest of the wall. The color of the wall will govern the color of the shadows and no general rule can be given. However, in the particular case illustrated, dark grey shadows against a cream board proved very effective.

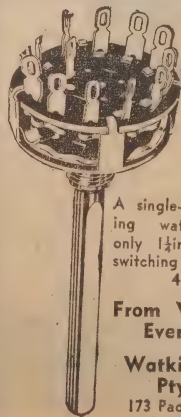
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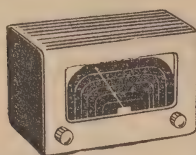
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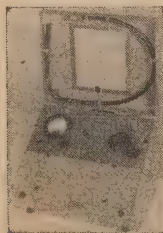


ONE-VALVE KIT SET FOR THE LEARNER

Although this little set is quickly and simply built, it looks like a factory-built job. The wooden cabinet is covered with burgundy leatherette and the dial has all Australian stations marked in different colors. Parts are mounted on a wooden base-board and anyone can build it if they can use a soldering iron. Circuit diagrams, wire, solder etc., supplied. Price for complete kit of parts, including Valve, Headphones and Batteries at normal price is £8/5/-.

Our price is £5/19/6

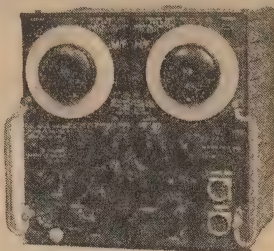
Weight 9lb 2oz.



WAVEMETER TYPE M.P.

Frequency range 176 to 220 MC/S. Each unit equipped with 4-IP5GT and 2-958 valves a 3 1/2 in. Diam. 0-1 ma meter, vernier dial and many other parts all in solid metal case 13 x 11 x 6 inches. This should be a valuable instrument when television arrives. These units are brand new.

Price only £7/10/-



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In good condition with all valves. Frequency 140 KC to 20MC. Provision for 6 crystals. Valves used:— 2-6V6, 3-807 Valves.

Price £9/5/-

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2. 6 Volt Vibrator transformers suitable for 5 valve car radios small amplifiers, home radios etc. Worth 37/6. Our Price 16/9.
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4. Large curved straight line Radio Dial as used on Philco Radiola etc, fits on front edge of console or radiogram cabinet. Worth £3/10/- Our price 19/6 each.
5. Germanium Diodes ideal for detectors in Crystal sets and also for rectifiers. Brand new. Only 4/11 each.
6. Cosmocord Crystal, Pick-Up cartridges complete with needle screw. Suitable for replacement in most crystal pick-ups. Worth 32/6. Our price 7/6 each.
7. High Impedance Headphones Impedance 4000 ohms, adjustable for maximum sensitivity, light weight, fitted with cord and plug a very fine phone suitable for crystal and valve radio receivers. Geiger counters etc. German manufacture, brand new and boxed. Price 39/6 pair.
8. English 3 Speed gramo motors suitable for 240 AC supply, adjustable knob for 33, 45 & 78 RPM. Will give excellent reproduction of both standard and microgroove recordings. Worth £8/10/- Our Price only £5/10/-.

9. Crystal Pick-Ups suitable for above motor. Twin head type. Worth £8. Our price £6. Turnover Head type. Worth £4/15/-. Our price £3/15/-. Variable Reluctance Magnetho Pick Up No. 500 with turnover head. Price £7/10/- All these Pick-ups have built-in sapphire needles.
10. Resin Cored Solder. 1lb reels. Worth 17/- lb. Our price 9/6 lb. A Special price for quantities.
11. Paper Tubular Condensers. Brand new, well known make:—

Capacity	Wkg	Volts	Type	Usual Price	Our Price
.5 mfd	400V	Paper	3/6	1/3	ea
.02 mfd	400V	Paper	1/2	1/2	ea
.25 mfd	600V	Paper	2/8	1/-	ea
.003 mfd	400V	Mica	4/4	1/-	ea
.001 mfd	400V	Mica	2/9	9d	ea
13. Throat Microphones. Brand new. Only 5/- ea.
14. Padder Condensers suitable for 455 KC. Oscillator circuits adjustable. Worth 2/9. Our price 1/3.
15. Spring Gramophone Motors:— This excellent little wind-up motor is suitable for replacement in portable gramophones or for combined portable radio and gramophone. Complete with turntable and fittings. Only £3/10/-.
16. 250 ohm 25 Watt rheostats. Wire wound on Mica with porcelain insulation. 4/6 each.
17. 100 ohm Rheostats, heavy duty aircraft. 2/11 each.
18. 100 ohm Wire Wound Potentiometers — well known make brand new. Worth 9/6. Our price 4/6.
19. 0-1 ma Meters — 100 ohms internal resistance. Sensitivity 1000 ohms per volt. Square face with 2 inch scale. An excellent meter for building, testing equipment, multimeters etc. Price only 32/6 each.
20. PE 94A. Genemotors. Input 28 volts. Output 300 volts DC at 260 ma, 150 volts DC at 10 ma, 16 volts DC at 5 amps. Enclosed in metal box with cooling fan, could be converted to 32 volt motor. Price 25/- each.
21. 807 Valves. Brand new and boxed Porcelain base. Worth 30/- Our price 22/6.
22. 866A Valves. Brand new and Boxed. Price 27/6 each.

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17-WATT ULTRA-LINEAR AMPLIFIER

(Continued from Page 65)

The voltage developed at the output grids with a VT voltmeter while feeding a signal into the amplifier had to be adjusted until the plate resistor values until these are equal. A good idea is to replace some of the plate resistance with a potentiometer as was done in the Williamson circuit, and adjust it until the grid voltages are equal at, say, 1000 cycles. The exact value of the plate resistors is not critical, and anything in the order of 50-60K will be in order.

Any unbalance will mean that the output valve will overload before the other, with a slight reduction in total output. However, it will be sufficient in most cases to use the conventional values shown in our circuit which are obtainable in preferred types. It might be worth checking them with an ohm-meter to make sure their tolerances are not in opposite direction.

OUTPUT BALANCE

The inverter holds its balance quite well up to about 50 Kc but after that we found some discrepancy.

The main and perhaps the only advantage of this inverter circuit is against the plate cathode type used in the Playmasters is that the output impedance presented to the output valves is the same, whereas with the other type the cathode

impedance is low and the plate impedance high.

We suspect that this might be important with the ultra-linear connection. Using last month's circuit, we found it impossible to get the lowest IM distortion without seriously unbalancing the output stage or the effective grid impedance to one side of the circuit.

The effect was not present with the output valves connected as pentodes, and the unbalance changed from one side of the circuit to the other when the coupling condensers to plate and cathode of the phase inverter were changed over.

RATHER PUZZLING

At the moment we cannot offer any final opinion as to why this should be so. It is the more puzzling because other ultra-linear circuits have been published using a similar phase inverter, and last month's amplifier, although not checked for this effect, appeared to behave quite well. It is apparently another by-product of the unorthodox use of the screen, and may be due to some phenomena such as Miller effect concerning the screen in which unbalanced input impedances would be significant.

This was one reason why we changed to the cathode coupled circuit, as the effect was not present when it was used.

The balanced output impedance of this inverter is likely to be valuable in future experiments with auxiliary feedback loops around each side of the output stage, which would be virtually impossible with the plate-cathode circuit. It also provides a very even overload characteristic in the output stage which is a desirable feature should the amplifier be driven hard.

The use of extra feedback loops could be most valuable in compensating for transformer deficiencies and avoiding the troubles, some of which we have mentioned, which are associated with large amounts of feedback with a single loop. Some amplifier designs already use similar ideas, and this is another matter we intend to pursue in the future.

MORE GAIN

The cathode-coupled circuit, unlike the plate-cathode type, gives considerable gain—about half that obtained from one section used as a straight amplifier, and we found that, with an initial pentode, the amplifier sensitivity was too high for convenient use with the control units. Our design figure was about 350 millivolts, and, to achieve this, we connected the pentode as a triode.

The EF86 makes quite a good triode with just about the required amplification. Its plate circuit is decoupled with that of the phase inverter—we obtained no extra stability from decoupling them separately.

(Continued on Page 111)

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ANSWERS TO CORRESPONDENTS

F.R.W. (Katanning, WA) comments on our "De-Luxe Crystal Set" and says that he has had good results from one using a commercial iron-core coil.

A. Many thanks for your letter and we may be able to follow up the suggestions at a later date. It is interesting to note that you got such excellent results from the circuit, although we doubt that it would be as good as the "De-Luxe", which is the best we have ever handled.

M.B., of Boronia, Vic. writes to inquire about the meaning, pronunciation, and Morse Code sign for the symbol "crossed O".

A. The "crossed O" is extensively used in the Scandinavian languages. Its pronunciation approximates that of the U in the French word "un". We are however unable to say how it is sent in CW.

P.H.H., of Lower Hutt, NZ, writes to us to inquire about a two-way intercom unit without a changeover switch. He is also interested in a small roving TV camera.

A. The idea of an intercom system which provides for simultaneous sending and receiving without being subject to feedback is not a new one. Indeed, the first experiments on this subject are said to have been carried out by Edison himself. Not so long ago, before the advent of carrier telephony, the P.M.C. has used such two way amplifiers on trunk lines. Instead of an extra valve, however, these amplifiers used a balanced bridge. A telephone engineer from your local exchange may be able to explain this system to you. Another way would be to use two amplifiers and a square wave oscillator to change them over at a very high audio frequency, which the speakers cannot reproduce.

We have not carried out any experiments with TV cameras, so we cannot give any information on portable TV cameras. If you wrote to the British Amateur TV Society, they may be able to throw some more light on the subject.

J.E.J., Mt. Gravatt, Brisbane, Qld. sends us a P.N. for circuits since received.

A. We have received your P.N. for

the circuits. Thank you for your prompt attention.

N.C., of New Lambton, Vic. writes to us to inquire how to obtain a circuit and parts list for an audio stage for a crystal set.

A. These circuits you inquire about are available through our 2/- mail service. They come complete with parts list and possibly with a wiring diagram. We do not know how much the parts would cost, but if you write to one of our advertisers, mentioning the parts you require, they should be able to give the information.

S.D. (Northam, WA) sends a number of questions which he would like to see answered in Answer Tom.

A. Many thanks for your suggestions, S.D., and we will try to deal with these as you suggest. In the meantime the explanations are, briefly, as follows: The AVC system does operate by means of a bias voltage applied to the signal grid of the IF converter, and RF stage (if any). If you trace a typical circuit you will see that the "bottom" of the secondary, or grid, coil in each case does not return directly to the chassis, but to a network of resistors and capacitors which comprise the AVC line. This eventually finds its way to the diode circuit, where is developed a negative DC voltage varying in strength according to the strength of the incoming signal. It is this voltage which biases the valves and controls their gain.

The local oscillator in a superhet does not squeak. If it did it would most certainly interfere with the incoming signal in the way you suggest. This sometimes happens when the oscillator grid resistor accidentally goes much higher than its rated value. The purpose of the padder is to help keep the local oscillator circuit displaced from the incoming signal by the value of the IF. The same effect could be obtained by using a gang having unequal sections for oscillator and aerial, but the use of a padder is cheaper and quite satisfactory.

A voltage doubler operates by charging, alternately, two capacitors which are in series as far as the discharge circuit is concerned. With both charged to the

voltage available from the rectifier, and connected in series, the available voltage is doubled, or very nearly so.

A.M. (Brisbane, Q) asks a number of questions concerning records' also expresses an interest in AC/DC for use on board ship.

A. Many thanks for your suggestion and kind remarks, A.M., and we will do our best to help. In general, we do not keep on encouraging our readers to the building of AC/DC sets. Unless you know exactly what you are doing these things can be very dangerous, particularly on board ship where the "earth" of the metal frame of the ship. We do publish some typical circuits in the August and September, 1942, issues and we can probably supply copies through the query service. However, there is rather more to one of these devices than can be shown in a circuit. The question regarding re-recording of old recordings is an interesting one and there are many possible approaches. Originally, masters were made on the so-called "twax" from which the masters were made, the wax being destroyed in the process. This means that the only master available would be the metal stampers or the copper "mother" from which fresh stampers could be made. The frequency response of early records would be limited, though the greatest defect would probably be the noise inherent in the material normally used to press them. Assuming that a new record was pressed in one of the modern materials which would be very much quieter than the old copies. Re-recording this on to microgrooves should not add too much to the noise level and produce a disc which would have the advantage of long playing if the subject matter warranted.

The screen voltage is not always reduced in proportion to the plate voltage and, in fact, it is common practice to retain the screen voltage as high as possible, even if the plate voltage must be reduced. This applies particularly to RF and IF stages, where the gain can be kept quite high so long as the screen voltage is not reduced.

T.L. (Glenfield, NSW) has built the D.L. crystal set but rather disappointed with the results, being able to receive only 2FC and 2BL. He is also some trouble with a battery portable which has been modified for headphones.

A. We think it likely that your location is fairly reasonable for the performance of your set, but it may be possible to improve results a little by provision of a better earth and some careful adjusting of the coils. The best earth is water pipe connection and we doubt whether the rainwater pipe connection you are using will give the best result. Failing a water pipe connection a length of pipe driven into the ground and kept moist is about the best arrangement. A large metal plate buried several feet down can also be used and is quite effective. Bringing the aerial tap further down the coil toward the earth end may reduce the coupling between the coils and may reduce the strength of 2FC and 2BL to the point where you may be able to use the stronger commercial station.

It is not possible for us to give you any exact information about failure of the portable to operate on the speaker since we have no idea of the change made by the serviceman or the manner in which you have tried to reconnect it. We can only suggest that you enquire the aid of another serviceman if the first one cannot be contacted.

T.W.B. (Fairymeadow) comments on the letter reproduced on page 81 of the October issue last.

A. Many thanks for your letter and for the comments. Your summary of the situation is quite correct. However, we rather gather that you did not read our own comment on the letter, which appeared toward the end of the Argus feature on page 85 of the same issue.

THE RADIO, TV & HOBBIES QUERY SERVICE

All queries concerning our designs, to which a POSTAL REPLY is required must be accompanied by a postal note or stamps to the value of TWO SHILLINGS.

For the same fee, we will give advice by mail on radio matters, provided the information can be drawn from general knowledge. UNDER NO CIRCUMSTANCES, however, can we undertake to answer problems involving special research, modification to commercial equipment or the preparation of special circuits.

Whatever the subject matter, we must work on the principle that a letter is too involved if the reply takes more than 10 minutes of our time.

Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cut-outs in standard chassis will now be 4/6. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, "RADIO, TV and HOBBIES," Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

17W AMPLIFIER

(Continued from Page 109)

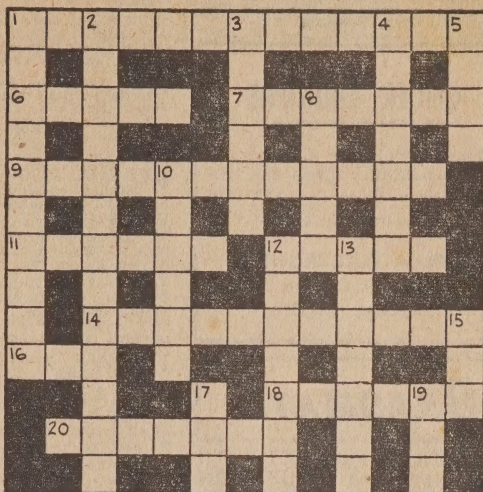
THE R. & H. CROSSWORD No. 9

ACROSS

1. Produced by current flow
6. Inductors
7. Half-wave aerials
9. Oscilloscope plot
11. To treat with heat
12. Summary of contents
14. Replaced B-batteries
16. Noise
18. Secondary Ohms (abbrev.)
20. 5-Element valve

DOWN

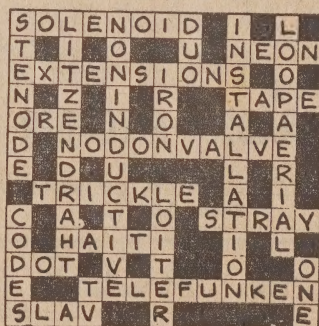
1. Unit of capacitance
2. Feeds detector grid
3. Interior
4. Oval shape
5. Morse symbol



- | | | |
|-----------------------------|--------------------|-----------------------------|
| 8. Type of crystal detector | 12. Conductive gas | elevated temperature |
| 10. Part of aerial system | 13. Demodulates | 19. Eliminated by HT filter |
| 15. Total | 17. At an | |

Solution and further crossword next month

Solution to Puzzle January Issue



Good business

NINE new "TV detector" vans put into service in England paid for themselves within a week.

Cost of the vans was covered by new radio and TV licences since the vans were put on the job of catching unlicensed receivers.

This was stated by a GPO spokesman, who described the results as "astonishing".

At Coventry, where the vans began their search for unlicensed sets, 522 TV licences and 388 radio licences were taken out in four days.

About 370 radio licences were exchanged for television licences.

This compared with the normal sale of 60 licences weekly.

for which we have designed, no fears need be entertained about valve ratings.

The output valves could be replaced by 6L6's or 807's without circuit changes, the only difference being a drop in maximum output to about 10 watts.

Incidentally the transformer specified—4500 ohms plate to plate—can be used with these valves in either pentode, triode, or ultra-linear connection. The screen tapping may be at any position between 15 and 20 pc of the output load impedance without seriously affecting results.

FREQUENCY RESPONSE

Apart from the performance curves included in this article, which are typical of this amplifier, it may be said that, through the No. 6 control unit, the response is flat from 20 to 20,000 cycles, allowing for compensation and is 6 db down at approximately 70 Kc due to the characteristics of the unit. The maximum power output at 1 Kc is about 17 watts, with about 14 watts available at 20 cycles and 20 Kc.

Square wave oscillogram photographs are included showing the wave-form at 1 Kc and 10 Kc, and the wave-form at 20 cycles with an output of 14 watts. There is also a photograph of square wave response through the control unit.

These indicate an extremely high order of performance, quite comparable with the best amplifiers available at the present time in any class.

It should be mentioned that the characteristics of the output transformer at extremely low frequencies is an important factor in avoiding motorboating, and, although we have used large cathode bypass and coupling condensers to preserve low frequency response, there should be no troubles of this kind with high grade transformer.

The bypass condenser across the feedback resistor is intended to correct possible positive feedback at extremely high frequencies and possible ringing or instability.

Its value will undoubtedly depend on the transformer used, but, from our tests, a value of 100 or 200 pf has been sufficient without seriously affecting high frequency response up to 50 and even 100 Kc. It should not be necessary to use a higher value, and greater capacitance may even cause high frequency oscillation.

NOT CRITICAL

We have not found it necessary to use phase-correcting circuits in the output stage or elsewhere in the amplifier. The presence of such circuits indicates individual "tailoring" to suit a particular design, and this means that it has been necessary to correct for deficiencies.

Constructionally the amplifier could be simple. The original laymaster No. 1 chassis was used to accommodate the large transformers and filter choke, and most components are supported on a central terminal strip or wired to it directly from the valve sockets. The EF86 bias resistor and condenser are easily identified, followed by the plate resistor, 6SN7 cathode coupling and plate resistors, and the two output stage grid resistors. The grid suppressors are wired directly to the valve sockets. One of the output grid condensers may be the other is tucked away under the strip.

The 6SN7 grid and bias resistors are also wired from the socket pins, and the grid .1 bypass is seen behind the socket.

The two main filter condensers are mounted under the chassis, one on each side. The leads from the output transformer are brought out to a terminal strip, and connections run across to the output valves. The two decoupling condensers are mounted above the chassis where we were using a 16 mfd decoupler in the control unit when the picture was taken, and this value may be increased should it be necessary to the specified 24 mfd or even higher.

HIGHER VOLTAGES

A feature of the EL37 valves is at their plate and screen voltage may be increased to 325 volts with no circuit alterations, but with a power output increase to about 30 watts. We are not suggesting you use this voltage without due consideration to the rating of filter condensers and other components, but does mean that should your power transformer give more than the nominal 260 volts plate to cathode

Wanted to buy, sell, or exchange

Cost of Classified advertisements in this section is 2/- per line, approximately five words to a line. Closing date for March issue of Radio and Hobbies is Wednesday, February 9.

GEIGER COUNTERS

Nuella Portable Counters

Aural Indication Type £26/10/-
Aural Neon Flash Type £32/12/6
Meter Reading Type £53/10/-

NUELLA ELECTRONICS

115 Alice St., Sans Souci, N.S.W.
Telephone: LW6778.

BRADMATIC

THE ENGLISH PRODUCT WITH THE UNIVERSAL REPUTATION HI-FI TWIN TRACK RECORDER HEADS.

New consignment from U.K.
5R.P. Record/Play frequency range 30-12,000 c.p.s. £6/3/-
6R.P. Record/Play as 5R.P. except for considerably improved frequency response and .0002 gap width £7/3/-
5E Erase Head. Erase frequency 30-100 k/cs. Erase power input. 2 watts £6/3/-
DIMENSION ALL HEADS.
Diam. .970in.
Single mounting stem 1.125in.
Height from panel 1in.
Also Bias rejector coils, play back amplifiers, recording amplifiers, oscillator coils, empty reels, all sizes.
Sole Representatives in Queensland, New South Wales and Tasmania for
BRADMATIC LIMITED, Birmingham, England.

BRADDECK RECORDER

COMPANY
MITCHELL ROAD, CRONULLA
Phone LB4402

FOR SALE: American Halliocrater. DW set 538 with transformer. £12. Phone JW2531.

FOR SALE: 8mm movie projector, new condition, £65/- cash, complete with carrying case. Details from Kevin G. Price, 329 Boorowa St., Young, NSW.

HIRE: your 8mm films from: Kevin G. Price's Film Library, 329 Boorowa St., Young, NSW.

SELL: R. & H. April, 1949 to March 1950. 150 V. transformers. Audio transformer. 3:1. Old wireless and cabinet. JJ3728.

FOR SALE: AWA battery type mod. osc. excellent condition £10. D. Dettrick, 43 Water St., Bundaberg, Qld.

FOR SALE: All back issues of R. & H., 1000 copies in stock. Write now to T. Weir, 73 Gibson Ave., Padstow. For prompt service, 4/- per copy incl. postage.

FOR SALE: Philips sig. gen. Perfect cond. £25. BC221 freq. meter, £85. Transf. generators, etc. cheap. UHF super regen receiver HRO. £10. 170 Dunning Ave., Rosebery, Sydney.

FOR SALE: Scope sig. gen. V/C tester, G.D. meter. Lot of ham gear, transformers, valves, etc. All good order. Cheap. Home Sundays. 68 Augustus St., Leichhardt.

FOR SALE: Guitar "moody mike". As new. £7/10/- . XW5844.

SELL: Four valve broadcast receiver in good condition, less speaker, £12 or offer. Apply H. W. Underwood, Tingoora.

SELL: Bargains, Goodmans 150, R.J. Cabinet 2 2 1/2 lbatt L.F. Pickups, 2 H.M.V. 12A Pickups and equalisers, 24 Milroy St., E. Brighton. XM3377.

SELL: Byer's professional S.5.A. cutter-head unit Royce Transverser or Byer's R-D-12 recorder, £35. C. Savitsky, 5th Ave., Wilston, Brisbane, Qld.

SELL: Flexaret 3.5 Twin lens reflex S camera, auto film winding also Dejur Exposure Meter perfect. Cost £45. Sell £28/10/- including E/R case. 26 Avon Rd., Dee Why, NSW.

KEVIN G. PRICE for all your 8 mm, 16 mm and 9.5mm cameras and projectors. Sound and silent from £11/10/- . Kevin G. Price, 329 Boorowa St., Young, NSW.

WANTED: Lexington P-U, any order. Dark. BO236, Sydney.

WANTED: New or secondhand copies of any radio books containing the elementary and slightly advanced stages of radio. Write and state price. T. Sullivan, Box 35, Caulfield, Victoria.

COMP. Am. Stn. Mod. No. 20 Tlx 13T RX. Class "C" Wx Xtal Cal. Olsson, 145 Taren Rd., Caringbah. BO255 9-5.

PRINTING: Business cards, 100 for 15/- . Letterheads, cards for all occasions. 20, Bagery Avenue, Homebush. UM9944.

PERSONAL

AUTHORS invited submit MSS types (including Poems) for book publication. Stockwell Ltd., Elms Court, Fracombe, England. (Estd. 1898).

SUN'S ENERGY

(Continued from Page 13)

transistor, to power a radio transmitter.

The tests showed that six per cent of the available radiation energy has been converted to electricity. This is a higher efficiency than is shown by most plants in their use of sunshine.

With such efficiency and with moving parts, so that it should last indefinitely, this solar battery expected to be developed rapidly as a source of small currents in isolated locations. The present obstacle to be overcome is to obtain large enough sheets of silicon.

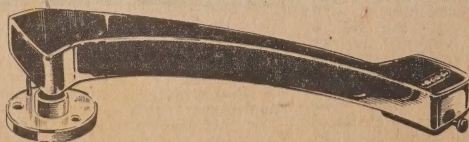
The disadvantage of all the methods of utilising sunshine correctly is that they operate only while the sun is shining brightly and not on cloudy days or at night. What they lack for general usefulness is a means of storing the energy that they get from the sun.

For this reason scientific interest is still fixed on understanding the process by which green plants absorb sunshine and use that energy to manufacture wood, fibres and starches.

The energy is stored in the materials in chemical form, when they are later used, either as food or as fuel, they release their stored energy by combustion. The process, called photosynthesis, is somehow conducted without a rise in temperature by the green coloring matter, called chlorophyll, that is present in all green vegetation.

Since it is the mechanism which all life depends, whether plant or animal, and since it manufactures both food and fuel, it is one that must soon be mastered to meet the needs of the growing world population. Meanwhile, photosynthesis remains the most persistent to man's curiosity and skill in scientific research. (Editor's note: Since this article was written a news item published claims that photosynthesis has been duplicated in the laboratory—a most important step, according to Dr. Wendt.)

THE "ACOS" MAGNETIC PICKUP



GP32
£2'12'6

Provides a good standard of reproduction with normal equipment at a reasonable price. Element incorporates new high-permeability sintered bi-metal magnet. Output voltage — $\frac{1}{2}$ volt at 1000 cps.

Available from leading radio houses everywhere

Precision Turned Aluminium Turntables and Shaft Complete

Drop in replacement for MU1 and GU4 B.S.R. motors. Eliminates wow and flutter. £6/7/6, postage 3/6. Bearing can be supplied for about 15/- each. Agents for Crystal High Frequency Speakers.

A. F. KNOWLES

149 Union Rd., Surrey Hills, E.10. Vic. Phone WX3602.

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